# SCIENTIFIC MANAGEMENT

FIRST CONFERENCE AT
THE AMOS TUCK SCHOOL
DARTMOUTH COLLEGE

Dartmouth College Conferences

First Tuck School Conference

# SCIENTIFIC MANAGEMENT

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# ADDRESSES AND DISCUSSIONS AT THE CONFERENCE ON SCIENTIFIC MANAGEMENT HELD OCTOBER 12 · 13 · 14 NINETEEN HUNDRED AND ELEVEN

THE AMOS TUCK SCHOOL OF
ADMINISTRATION AND FINANCE
DARTMOUTH COLLEGE
HANOVER, N. H., U. S. A.
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TO EDWARD TUCK

FOUNDER OF THE AMOS TUCK SCHOOL
OF ADMINISTRATION AND FINANCE
WHOSE DESIRE THAT THE SCHOOL
SHOULD BE OF SERVICE TO THE STATE
AND TO THE NATION INSPIRED
THE CALLING OF THE CONFERENCE
OF WHICH THIS VOLUME
IS A RECORD

## ACKNOWLEDGMENT

*THE AMOS TUCK SCHOOL desires to make acknowledgment of its indebtedness to many persons not resident in Hanover for that generous coöperation which made possible the success of the conference:*

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*Particularly to Morris Llewellyn Cooke, Consulting Engineer, Philadelphia, since appointed Director of Public Works of Philadelphia, of whose wise counsel and active help, sought by the School in every step of planning and performance, the conference and its record are a testimony.*

# CONTENTS

## INTRODUCTION



## First Session

### THE PRINCIPLES OF SCIENTIFIC MANAGEMENT



## Second Session

### SCIENTIFIC MANAGEMENT AND THE LABORER

## Third Session

### SCIENTIFIC MANAGEMENT AND THE MANAGER



## Fourth Session

### DISCUSSIONS OF THE APPLICABILITY OF SCIENTIFIC MANAGEMENT IN CERTAIN INDUSTRIES

## Fifth Session

### SCIENTIFIC MANAGEMENT AND GOVERNMENT



## Sixth Session

### PHASES OF SCIENTIFIC MANAGEMENT

# Introduction

BY HARLOW S. PERSON

*Director of the Amos Tuck School, Dartmouth College*

# SCIENTIFIC MANAGEMENT[1]

HARLOW S. PERSON

WHETHER Scientific Management is something new or is a new name for old principles and mechanism of organization and management is relatively unimportant. What is important is that it has recently been given an extraordinary amount of attention in newspapers and in magazines, and that notwithstanding this large amount of exposition and discussion there seems to be no general understanding of its nature and of its operation. Both its principles and its mechanism must be understood before further discussion can be really profitable. The purpose of this first Tuck School conference is to enable business men and manufacturers of New Hampshire and of New England to meet the organizing engineers who have applied Scientific Management and the manufacturers in whose plants it is in operation, in the hope that they may carry away from the conference an understanding of its principles and that they may form sound judgments concerning its applicability to their respective businesses.

The fact that there are so many contradictory opinions concerning Scientific Management suggests that there must be in it something of a new philosophy of management, and that it must be worthy, for that reason if for no other, of serious investigation. Whether one considers it a new philosophy of management or whether one considers it a gathering together of the best of old devices of management, depends primarily upon whether one begins with an examination of the whole or with an examination of the parts. The aero-

[1] An address delivered before the Social Science Club and the Dartmouth Scientific Society, of Dartmouth College, and published in *The Dartmouth*, a student newspaper, preliminary to the conference.

plane furnishes an analogy. If the inventors of the aeroplane had brought its parts one at a time before the public and proclaimed each as something new, they would have been ridiculed. But when the perfected aeroplane was brought out and men actually flew, the Wrights were acknowledged great inventors. Old and familiar mechanical devices had been brought into a new relationship expressing a new ideal. In a like manner many writers and speakers have observed only the devices of Scientific Management and have pronounced them old and familiar. They have failed to see the whole and to appreciate the view that it is a union of many old devices with a few new ones in a relationship expressing a new ideal of business organization and management.

Scientific Management is said to be a third stage in the development of organization. The first stage was represented by the non-systematized business, of which there are to be found survivals among older and smaller plants. In this stage the management grew up with the plant, was inbred, and was bound by traditions handed down from manager to manager. There were, of course, in the period of non-systematized business general improvement and brilliant examples of the development of new methods, but the period was one of high profits and of little incentive to improvement, and new methods came fortuitously and spread only by imitation.

The second stage of organization is represented by the systematized business, characteristic of the last two decades. During the period following the Civil War, improvements in transportation destroyed isolated markets, brought more intense competition and reduced the margin between raw material cost and selling price. This situation compelled many managers, who might otherwise have remained bound by tradition, to seek by improved methods and organization a reduction of the costs of manufacturing processes. Chemistry was called in to make salable products of what had been waste; blank forms of great variety were devised to keep account of materials and of labor that there might be no misapplication and waste of these; as units of business became

larger, printed and written directions came to replace personal oversight and instruction by the manager, and systems were devised to effect the smooth working of routine. Cost accounting, the sextant and compass of the business man, was more highly developed and more generally adopted and this required the systematization of processes.

Systematized management is not Scientific Management, say the advocates of the latter. Under the former tradition remains dominant; improved methods are acquired by experiment, it is true, but not by the precise laboratory method of the observation and measurement of a large number of units; new methods become known by imitation rather than by teaching; and, the reduction of a cost once accomplished, it is common to accept the result as final, because the solution of an immediate problem, rather than as a step only towards greater improvement.

The third stage in the development of organization and management, they say, is that of Scientific Management. Nor is it merely theory, they insist further. During a period of thirty years its principles have been in process of working out and, during a briefer period, of application. Plants employing an aggregate of 50,000 men have adopted the new methods. Witness after witness testified before the Interstate Commerce Commission that he was connected with the management of plants employing these methods, and presented an impressive array of facts concerning its results, — greater productivity, greater profits, higher wages and reduced prices to the consumer. If Scientific Management be universally applicable in business organization and management it may truly be "the most important advance in industry since the introduction of the factory system and power machinery."

Mr. Taylor insists that the general principles, or philosophy, of Scientific Management should not be confused with the mechanism, which is merely incidental. He emphasizes four fundamental principles. First: the method of Scientific Management is the method of a true science. The organizing engineer "objectifies" a plant to be organized; he enters

as an "outsider," bound by no traditions and prejudices of its management, holds it, so to speak, at arm's length, studies it by departments and as a whole, compares it with other similar plants of his experience and observes defects that the "insider" does not see. In this process the truly scientific method of analysis into units and experimental recombination of them is followed; not superficially, but exhaustively, until enough data are collected from which trustworthy laws may be derived. There is one case of experimenting by Mr. Taylor in which nearly 50,000 experiments were carefully recorded, classified and studied, 800,000 pounds of steel and iron were cut up into chips, and nearly $200,000 were expended. This observation is not confined to machinery and material only; it is applied also to men and, for illustration, laws of fatigue and recovery from fatigue are discovered. In accordance with laws thus derived, standards of productivity are established and the methods of their attainment set forth in rules. In this observation and experiment and in the derivation of laws there is no assumption of finality. The organizing engineer does not stop when a reduction in cost is effected; he assumes that there is always the probability of further important discovery of new laws, and observation and experiment do not cease. This attitude of mind and these methods, says Mr. Taylor, justify the claim that the new management is a science.

A second general principle of Scientific Management is that there should be, and as a result of the laws derived by observation and experiment may be, a scientific selection of machines, material and workmen. For instance, by a careful study of each individual of a group of men in any department, it may be found that many are not physically or temperamentally adapted to performing the particular functions required in that department and that they are adapted to the performing of functions in some other department. There follows a redistribution of men between departments with the result that, without an increase in aggregate energy expended, there is an increase in aggregate

productivity. It is the scientific method of adapting instrument to purpose.

The third principle of the new management is that, a workman once discovered and assigned to the performance of the function to which he is adapted, the management should provide continuous instruction for him. From this point of view the factory should become a school; the workman should be instructed how to use the most efficient method with the greatest skill.

The fourth of Mr. Taylor's principles of Scientific Management is that there should be intimate coöperation between management and men and a redistribution of responsibilities. The workability of the new management, says Mr. Taylor, depends upon such sympathetic coöperation. There must be mutual recognition of the possibility of mutual helpfulness. This recognized, there must be a readjustment of duties, for under present systems of management there is required of a workman so much as to make impossible his highest efficiency. The manager, under the present system, requires of the workman simply the accomplishment of a certain result. To the workman is left the determination of the method as well as the actual performance. Under Scientific Management the experts in the planning room determine the method and leave to the workman freedom to apply all his energy to actual performance.

These four general principles constitute, according to Mr. Taylor, the philosophy of Scientific Management. The devices employed to give effect to these principles constitute the mechanism. The philosophy and any particular mechanism are not to be considered equally important. In Mr. Taylor's own words, "Scientific Management fundamentally consists of . . . a certain philosophy which can be applied in many ways, and a description of what any man or men may believe to be the best mechanism for applying these general principles should in no way be confused with the principles themselves." But certain parts of the mechanism now advocated by the organizing engineers are of great importance because they

seem to be necessary to the application of the principles and because one of them in particular is opposed by many employees as competent, in their judgment, to produce indirect results harmful to their productive group.

Scientific Management aims to produce at least five results, all of which must be produced before such management can be said to be established, and for their production specific devices must be employed.

*First*, Industrial processes must be reduced to units before scientific observation and experiment are possible. The most important device for this purpose, the *time-study*, aims to reduce the operations of workmen to fundamental motions and to ascertain, for example, the shortest, longest and average time required for each motion. From experiment with these data a standard time for the performance of each operation is derived.

*Second*, This standard time in which a given operation is to be performed having been ascertained, it must be set before the workman as something to strive for. To accomplish this the device of the *task*, sometimes called *standard time*, is used. With each order which goes into the shop is advice concerning the average time which should be required to produce each unit of product and which represents the standard of efficiency.

*Third*, The workman must be instructed how to achieve this standard. He must have at hand a sympathetic, expert director who is teacher rather than boss. The device of *functional foremanship* is intended to effect this. The functional foreman teaches all the workmen who have to perform a given function, e.g., set a tool in a lathe, exactly how to perform that and no other function. He is an expert workman become teacher. The foremanship of Scientific Management, therefore, requires in a given plant as many foremen as there are functions to be performed there. The foreman of the usual organization, on the other hand, is the boss of all the men in a given room with respect to all functions performed there. He may be expert in one or more of the functions, but

seldom all, and too frequently considers himself driver rather than teacher. This foremanship requires in a given plant as many bosses as there are departments.

*Fourth*, Scientific Management aims to relieve the workmen of responsibility for determining how a process is to be performed, especially if the method is one which may be exactly, i.e., scientifically, determined, and to leave him free for the development of manual dexterity. This is accomplished by the *planning and routing room*, a managerial department which works out and sends with each production order precise specifications for the operation. If it be an assembling job, for instance, the parts to be assembled, their relative positions around the workman at the beginning of the job, the order in which they should be brought together, etc., are specified. The workman does not need to plan; he proceeds at once to performance.

*Fifth*, The workman must be inspired to accept the new methods; to strive to acquire dexterity in carrying out specifications sent him. Workmen, like managers, like any other large body of men, have fixed habits from which it is difficult to turn them. How inspire the workman to make the change? The result is accomplished by a differential wage system, a device which gives him at once, in a way perfectly obvious, a share of the increased productivity, instead of compelling him to wait for the slower, less obvious, redistribution of shares which would work out under the usual system of payment by the hour or day. These differential wage systems vary, although they are in principle the same, primarily according to the proportion of the increased productivity apportioned to the workman. One system gives the workman, say 30 per cent, of the increased returns; another gives him practically all.

It is neither the philosophy nor the interesting mechanism of Scientific Management which has aroused such wide-spread interest; it is the story of its astonishing results. In Mr. Taylor's own words, workmen "are receiving from 30 per cent to 100 per cent higher wages daily than are paid

to men of similar caliber with whom they are surrounded, while the companies employing them are more prosperous than ever before. In these companies the output, per man and per machine, has on an average been doubled. During all these years there has never been a single strike among the men working under this system. In place of the suspicious watchfulness and the more or less open warfare which characterize the ordinary types of management, there is universally friendly coöperation between the management and the men." Strong as it is, it must be said that on the whole the testimony of the executives of plants so managed corroborates this statement.

Mr. Taylor's statement was made in January, 1910. Since that time there has appeared strong criticism of Scientific Management, especially by officers of labor unions. It is possible that the publicity given it by testimony before the Interstate Commerce Commission has caused these union officials to examine it more closely with reference to its possible influence on the future of labor and particularly of unionism.

There have been nine principal criticisms of Scientific Management. Three are concerned with its effect on the individual workman, physically and temperamentally. The others are concerned with its influence on labor as a productive group.

*First*, The taking of time-studies and the determination and setting of a task are a reflection upon the good faith of labor. It sets up the relationship of master and slave. This criticism is undoubtedly prompted by a sensitiveness which is aroused by too much emphasis, in expositions of Scientific Management, upon the treatment of labor. Most expositions have been for the benefit of management, and have emphasized the handling of labor. In the application of Scientific Management, however, the managerial force is studied just as keenly and reorganized just as thoroughly as is the labor force. Each person concerned with the executive operations has a task and is held strictly accountable for its

performance. In plants in which Scientific Management has been applied, and in such plants only, is labor enabled to judge of the efficiency of the executive force and to hold it up to established standards of efficiency. Scientific Management recognizes no difference, in determining standards of efficiency, between management, capital goods and labor.

*Second*, The removal from the workman of individual responsibility for determining the method of an operation and leaving to him attention to the skilful performance only, makes his work uninteresting and monotonous and is bound to stunt him intellectually. My own observations and the observations of others in plants where Scientific Management has been applied do not support this criticism. The first error in the criticism is the assumption that taking from the workman the necessity of going after and selecting the proper kinds of material, tools, etc., — and that is one of the principal responsibilities of which the redistribution of duties deprives him — takes from him something intellectually stimulating. Another error is the assumption that performing an operation according to the best method is intellectually less stimulating than performing it according to an inefficient method. A third error is the assumption that a method handed down by tradition is intellectually more stimulating than a method derived by experiment.

*Third*, The effect of Scientific Management is to "speed up" the workman, wear him out and cause him to be cast aside. Again, actual investigation in plants so organized does not support this criticism. Its error is the assumption that the increased productivity comes from a greater expenditure of muscular and nervous energy in a working day. The increased productivity comes, however, from other things; from saving in overhead charges, from the using of material in a predetermined correct way, from the using of machinery in a predetermined most efficient way, from the elimination of the time a workman wastes in going after material and tools, from the elimination of the misapplication of muscular and nervous energy in unnecessary motions, and from compulsory

periods of rest, even, which the workman will ordinarily not take for himself. The beginner at golf expends more energy in a round of nine holes than the experienced player in a round of eighteen; the skilful carpenter expends far less energy in planing a board than does the novice. Scientific Management strives to teach the workman skill, and to prevent over-exertion as much as to prevent loafing. One of the most impressive things to the visitor at a plant so organized is the absence on the one hand of loitering and on the other hand of haste.

*Fourth,* Scientific Management is inapplicable because of the mobility of labor; to teach the laborer the best method requires that he be retained for a period, but as a rule labor is continually coming into and going out of a plant, and before a laborer becomes skilful he is off and a new, awkward man has been hired to take his place. This criticism over-emphasizes the mobility of labor; it premises a mobility which the average manager does not experience. I once asked the manager of a plant organized according to the principles of Scientific Management what was the average time a workman remained with him. Eight years, he replied. He stated further that the average time was increasing under the new conditions of organization. Scientific Management carries with it its own corrective of the loss which comes from too great a mobility of labor. The fact that a workman is permitted to work under conditions which render him more productive and that he is paid according to his ability keeps him in the plant.

*Fifth,* It inaugurates a spying system among the laborers which results in mutual distrust, quarrels and absence of esprit. I do not know what is meant by spying system, unless it refers to the supposed fact that, in a sequence of processes, if one workman fails to keep up to standard, it will cause loss to another workman who to protect himself will have to complain of the first workman. This criticism is due to assumptions concerning Scientific Management which are not true. No workman has to complain of another; if

a workman is derelict the fact is reported automatically to the management by the impersonal time slip, and it is the duty of management to relieve the situation before any other workman can become aware of it. The relationship is not between workman and workman, but between workman and the order-of-work clerk. The persons of whom the workman may have occasion to complain are those in the routing, an executive, department. And as a matter of fact, finally, I have not observed, and no one has reported that he has observed, in a plant in which Scientific Management has become well established, any lack of harmony in the labor force; on the contrary, it is the consensus of opinion that a fine spirit of coöperation is conspicuous in such plants.

*Sixth*, Workmen have had a bitter experience with the piece-rate system; have been "speeded up" by increases in piece-rates only to have the rates cut. May not the differential wage system of Scientific Management be used against the workman in a similar way? This is a reasonable question. Such a manipulation of the differential wage system seems to me to be possible, but I doubt whether it is probable. In the first place, the experience of manufacturers who have reduced piece-rates has been as bitter as the experience of the laborer. They are coming to consider the rate-cutting of the past as one of the great blunders of management. It will take exceedingly strong temptation to induce them to try it again. In the second place, piece-rates in the past have been established without a sufficient knowledge of the conditions of production. They gave to the workman all the increase of production except that resulting from reduction in overhead costs. The invention of new and improved machines brought practically nothing to management, and placed it at a disastrous disadvantage in competition with firms paying day-wages, to which came all the advantages of the introduction of more efficient machines. Rate-cutting was compelled by the circumstances of competition. Under Scientific Management, on the other hand, rates are determined only after exhaustive investigations of the productivity of a laborer in combination

with a given machine, and a separate rate is established for every such combination. If a new and more efficient machine is introduced, a new rate is established as the result of a new investigation. So long as plants organized under Scientific Management enjoy the resulting differential advantage in competition with plants paying day-wages, there will be little danger of rate-cutting, for in proportion as the earnings of workmen increase does the unit cost of the product decrease. If the time should come, as it is reasonable to expect it will come, when all plants in a competitive industry should be organized according to the principles of Scientific Management, so that the differential advantage would no longer exist, there might be temptation to rate-cutting. But under those conditions the temptation would be no greater than to cut under the day-wage system. And if unions still existed labor would be in as good a position to protect itself in the one case as in the other.

*Seventh*, The increase of efficiency which results from Scientific Management will throw labor out of employment. The untenable assertion that such would be its ultimate effect is not deserving of serious consideration. But that there may be temporarily such a result in a given industry is possible, if increased demand resulting from decreased selling price should not *pari passu* accompany increased efficiency in production. It is good economics to assume that in the long run improved methods will make employment for a larger number of persons; but it is also good sense for the laborer to take into consideration the possible immediate consequences of lack of employment for a season. The saving factor in the situation is that Scientific Management cannot be applied in a day. To apply it to a given plant is a matter of years. The organizing engineers capable of applying it with such results in increased productive efficiency as have been of late brought to our attention are and always will be few. If there is an impending revolution in industry comparable to the revolution at the beginning of the nineteenth century, it will be quite different in at least one respect;

systems of Scientific Management will not be turned out as was cotton and power machinery, in great quantities at a relatively low cost and standardized to fit any and all plants. Each plant presents a distinct problem to the organizing engineer, a problem of several years duration. There can therefore never be unemployment of a large body of men on account of sudden wide-spread more efficient organization. The firms which introduce Scientific Management usually enjoy such a differential advantage that they are able to make prices which enable them to increase their plants so as to take care of the small amount of what would otherwise be surplus labor.

*Eighth*, It is asserted that labor is not allowed to help fix the rate of compensation. Labor has as yet expressed no desire to do so. In all cases of reorganization rates have been fixed so that labor has been able to earn more than it has demanded. If the time should come, as it surely will come, when labor asks to be allowed a voice in establishing differential rates under Scientific Management, there is nothing in the nature of that form of organization to make it impossible. On the contrary, it is probable that such coöperation between management and labor would work out more smoothly than under present conditions. The methods of determining what the combination of a machine and a man can do is so scientifically accurate that facts could be easily ascertained, and both labor and manager are reasonable when they know the facts. Whether labor would enjoy the opportunity of helping fix rates would depend on the solidarity of the group in making its demand.

*Ninth*, It is asserted that Scientific Management would impair the solidarity of labor; that it would break down unionism by substituting individual bargaining in the place of collective bargaining for which unionism is now struggling. Scientific Management aims to do away with equal payment to all laborers irrespective of their productivity, but it does not aim to do away with collective bargaining. It is possible under Scientific Management for a union through its selected

representatives to take a part in determining what is the best method of performing an operation, what would be a reasonable task, and what would be a reasonable division of the increased returns. These things once determined, it would have to permit its individual members to be paid according to their individual contributions to the increased returns. Scientific Management would impair the solidarity of unionism to the extent that that solidarity is dependent upon flat hour-rates for all men; it would not impair the solidarity by making collective bargaining impossible.

I have not enumerated as a criticism of Scientific Management the assertion that a great number of inefficient, of "fake," organizing engineers is likely to arise to exploit the new profession and to work havoc with those plants whose managers they induce to accept their services. It is a real danger, but it is not a legitimate criticism of Scientific Management. Managers should realize that ability to organize successfully a business depends upon a combination of qualities not found together in many men, — largeness of vision, capacity for details, patience, tact which is born of sympathy, the capacity to analyze and to combine, and scientific knowledge of technical processes.

# First Session

THURSDAY EVENING, OCTOBER THE TWELFTH

CHAIRMAN, HONORABLE HENRY B. QUINBY
*Formerly Governor of New Hampshire*

# THE PRINCIPLES OF SCIENTIFIC MANAGEMENT

## INTRODUCTION BY THE CHAIRMAN

LADIES AND GENTLEMEN:

IT is certainly most gratifying to me to visit again this splendid college of which the citizens of New Hampshire are so proud. I congratulate the authorities of Dartmouth and of the Amos Tuck School upon having become leaders, by calling this conference, in the dissemination of knowledge of Scientific Management.

The scope of Scientific Management is broad. It is of importance to capital and to labor, to large corporations and to small concerns, to the superintendent and to the artisan, guiding the efforts of each into channels where there shall be the least loss of energy. It is not my purpose, in the presence of the pioneer in this science, to describe the methods advocated by him for the conservation of productive energy; but I wish to refer to one instance of the universality of its application which has come under my own observation.

I was recently invited to Fort Hancock, Sandy Hook, to see the big guns fired. The gunners made two hits out of three shots at a moving target six miles away, the guns being fired at intervals of thirty seconds. Remarking upon the speed and accuracy of the firing, my attention was called to a recent article by Lieutenant-Commander W. B. Tardy upon Scientific Management of the Navy, in which he explains most interestingly how such rapidity and precision are obtained by its application, and in which he gives proper credit to Mr. Taylor.

One of the honors which has been conferred upon me as presiding officer of this first session of the conference, is that of presenting to you a gentleman who needs no introduction to this audience, Dr. Ernest Fox Nichols, President of Dartmouth College.

## ADDRESS OF WELCOME

BY ERNEST FOX NICHOLS, LL.D.
*President of Dartmouth College*

MR. CHAIRMAN, LADIES AND GENTLEMEN:

IT is a very pleasant privilege to bid you who have come to this conference on Scientific Management a welcome to Dartmouth College. It is with great pleasure that the trustees place at your full disposal such hospitality and such means of comfort as may be provided in a country college. It is a very great satisfaction to all the friends of Dartmouth College that this first significant conference on the subject of Scientific Management should be held here. We are especially glad of it for two reasons:

The first is, that it affords the college a rather unusual opportunity to do a service to the state and to the nation in bringing together those who have developed this new science, and those who seek to know more of its application.

The second is, that we have in Dartmouth College a very large body of young men who intend going into commercial and industrial pursuits at the end of their college course. For several years past more than half the men who have left the college have gone into some branch of industry. The high example which this conference will set cannot fail to be of the largest profit to this growing group of young men.

Over a decade ago, when the proportion of the graduates of the college who planned to go into business careers began to grow rapidly, those who were in charge of the college at that time wisely foresaw that a progressive institution of learning could no longer neglect some of the wider principles which

govern in the world of business. They even more wisely foresaw, however, that the young man who would go into business later must be trained not only for the business methods of today, but likewise for the business methods of tomorrow. Consequently, it was concluded that the only foundation upon which it is safe to attempt to build a business man of the future is on the broad foundation laid in the earlier years of the college. At Dartmouth, therefore, was established the first graduate school of administration and finance in the country, and our experience, although it is still young, has proved to us that the foundation was a wise one.

The Amos Tuck School of Administration and Finance is entering upon its eleventh year. That body of underlying principles and practices called Scientific Management is not very much older. It is therefore a great pleasure to see the two, the Tuck School and Scientific Management, standing here together tonight in the attitude of mutual helpfulness.

The Chairman: On such an important occasion as this we should examine first the principles of Scientific Management; and it is fortunate that we have with us tonight the man who first began to study and to apply them systematically. He began as a common laborer, served his apprenticeship as pattern-maker and machinist, and finally became chief engineer of a great steel works. In that position he learned to know the problems of management and began those scientific investigations out of which grew Scientific Management. But he is not content with that great constructive work. A man of only middle age, he is vigorously young and busy, — so busy that he cannot afford, as he puts it, to work for money. Just as he devoted the earlier years of his life to faithful service for those by whom he was employed, he is now devoting himself faithfully and strenuously to the service of every one engaged in industry, — the laborer not less than the employer. That is why we are able to have him here tonight. It gives me pleasure to present to you Mr. Frederick W. Taylor.

## THE PRINCIPLES OF SCIENTIFIC MANAGEMENT

BY FREDERICK W. TAYLOR
*Consulting Engineer, Philadelphia*

Mr. Chairman, Ladies and Gentlemen:

On behalf of several of my colleagues who are here tonight, and more particularly on my own behalf, I wish to express the appreciation which we feel for the honor which is being conferred on us by the presence on this platform of the present governor of this state and of one of its most distinguished past governors. I think that I can say that it is the most distinguished honor which has yet been conferred on any meeting at which Scientific Management has been discussed, and we are deeply grateful that these gentlemen, busy as they are, should have taken the time and the trouble to come here.

There is one fact which has been impressed on me more than any other during the past six months. I knew it to be a fact before, but it had never been brought home to me in the same way as during the past six months. It is the fundamental and the very sad fact that almost every workman who is engaged in the mechanic arts, who is engaged in anything like coöperative work, looks upon it as his duty to go slow instead of to go fast. This is the most unfortunate fact in any way connected with Scientific Management, and the causes which lead to it should therefore be very carefully considered.

I may say at the start, that if any one is to blame for this attitude, we are, and not the laborers. It is our fault more than the laborers', that almost every workman looks upon it as his duty to do as small a day's work as he can instead of as large a day's work as he can. Now do not misunderstand me on this point; I am referring only to those workmen who are engaged in what may be called organized industry. I am not referring to the isolated men who work perhaps for themselves, perhaps for an employer with one or two

employees, but I am speaking chiefly of the great mass of men who are doing the industrial work of this country. This going slow, instead of going fast, to my mind is the most serious fact that we have to face in this country. It is certainly the most serious fact that is being faced by the English people at this time.

If any of you will get close to the average workman in this country — close enough to him so that he will talk to you as an intimate friend — he will tell you that in his particular trade if, we will say, each man were to turn out twice as much work as he is now doing, there could but one result follow: namely, that one-half the men in his trade would be thrown out of work. Now this fallacy is firmly believed by nineteen men out of twenty of all the workmen throughout the country, and, strange to say, I have found that perhaps three-quarters of the people in this country who have spent the larger proportion of their life in getting an education doubt very much if it would be of any great advantage to the working people to turn out more work than they are doing. The average man then, in all classes in this country, doubts if it would really be of any great benefit to the working people to turn out a larger output than they are now doing. Every labor union in this country, so far as I know, has taken steps, or is taking steps, to restrict output.

In this these men are strictly honest; they are doing just what you and I would do if we were in their position and held their views. If any of us thought that by increasing our work we should throw one-half of our friends out of employment, we should take the same view that they do.

This doctrine is preached by almost every labor leader in the country, and is taught by every workman to his children as they are growing up; and I repeat, as I said in the beginning, that it is our fault more than theirs that this fallacy prevails.

What men here — not more than two or three — have ever spoken to an audience of workmen and attempted to counteract that fallacy? Not more than two or three in

this audience have ever gone before an audience of working-men and tried to point out the truth, that the greatest blessing that working-men can confer on their brothers and themselves is to increase their output.

While the labor leaders and the workmen themselves in season and out of season are pointing out the necessity of restriction of output, not one step are we taking to counteract that fallacy; therefore, I say, the fault is ours and not theirs.

All that it is necessary to do, for any one who questions the fact whether it is a good thing for working people to increase their output or not, is to look into the history of any trade in this country. Look into the history of any trade in this country, and you will see that directly the opposite is true; that an increased output invariably gives more work to more men, and never in the history of the world has it more than temporarily, and then for only a very short time, diminished the number of men at work in any trade. That is the truth! Just look into any trade and you will see it.

I shall take the time to give one illustration only. Take the great cotton industry, one of the greatest industries of your state; one of the greatest, if not the greatest industry of New England. In Manchester, England, in 1840 or thereabouts, there were 5,000 cotton operatives. Power machinery began to be introduced in the cotton mills about that time, and the moment those 5,000 men saw the new machinery coming they *knew* that there would not be work for more than 1,000 out of the 5,000 in their trade. There was no question about it whatever. So what did they do? They did just what you or I would have done under similar circumstances. They broke into the mills where the machinery was being installed and smashed it up; they burned down the mills and beat up the "scabs" who were employed to run the new machinery; and they did it for self-protection, just as you or I would have done it, believing what they did as firmly as they did.

Now power machinery came in the cotton industry, just

as all labor-saving machinery is sure to come in any industry, in spite of any opposition from any source. It always has come, and it always will come. And what was the result? I am told that the average yardage of cloth now turned out per man in the cotton industry is about eight or ten times the yardage turned out under the old hand conditions.

In 1840, in Manchester, England, there were 5,000 cotton operatives; in Manchester, England, now there are 265,000 cotton operatives. Multiply that ratio by eight to ten and you will see that between 400 and 500 times the yardage of cloth is now being turned out from Manchester, England, that was turned out in 1840. Has that increase in production thrown people out of work? No. It is merely typical of what has taken place and is taking place in every trade. The increase of output merely means bringing more wealth into this world. That is the meaning of it; that now 450 times as much wealth in cotton goods is brought into this world as was brought in 1840, and that is the real wealth of the world. And the workmen, the trades union, the philanthropist or the mill owner who restrict output as a permanent policy (I do not mean to say it is not necessary both for workmen and manufacturers at times to temporarily restrict output) are about the worst enemies to their fellow-men there are. There is hardly any worse crime to my mind than that of deliberately restricting output; of failing to bring the only things into the world which are of real use to the world, the products of men and the soil. The world's history shows that just as fast as you bring the good things that are needed by man into the world, man takes and uses them. That one fact, the immense increase in the productivity of man, marks the difference between civilized and uncivilized countries, marks the one great advance we have made on 100 to 200 years ago; it is due to that increase of productivity that the working people of today, with all the talk about their misery and their horrible treatment, live almost as well as kings did 250 years ago. They have better food, better clothing, and on the whole more comforts than kings had

250 years ago. And that is due to just one thing, *increase of output.*

Take this matter of cotton goods. Tell the average workman of today that when he has a cotton shirt on he has a luxury. Will he not laugh at you? In 1840 a cotton shirt worn by a workman was a luxury; now every man, woman and child in every workman's family wears cotton goods as an absolute necessity. Just so with a hundred other things that we have come to look upon as necessities, which a hundred years ago were luxuries. And to what is that due? To the increased productivity of man.

I am talking so long on this subject because it lies at the very root of Scientific Management, for Scientific Management has for its object just what labor-saving machinery has for its object, *increased output per unit of human effort.*

The second cause for going slow is *entirely* due to us. I think we are more to blame than they for the first cause, the fallacy that the increase of output will throw men out of work, but we are entirely to blame for the second cause. *It lies in our own inefficient systems of management.*

The piece-work system has been introduced in the industries of this country to such an extent that hardly a workman can be found in any industry who does not know something about its working. All of you gentlemen doubtless understand all about the piece-work system. If you do, then I will remind you that when you put a workman on piece-work and ask him to make, we will say, ten implements like this slide-rule in a day, and offer to pay him twenty-five cents for making each of them, you count on his using his ingenuity and on his making a careful study of the methods by which he is going to make them, and so increase his daily output. You hope that later instead of making ten pieces per day, he will make twelve, fourteen, fifteen or even twenty pieces a day. This is the hope of the manufacturer.

We will assume that that workman knows nothing about the piece-work system. With the opportunity before him to have his ingenuity and his harder work rewarded by getting

more pay per day, he would very likely, after six months or a year, learn how to make fifteen of these pieces instead of ten, or, let us say, twenty instead of ten. If he made twenty he would be earning $5 per day in place of $2.50 which he earned before he was put on piece-work.

The foreman over those men, we will say, is a straight, square man, and in all honesty he encourages them to turn out more than ten pieces; we will say he encourages them to get out twenty pieces. Now in almost all boards of directors of our companies there are a number of very wise gentlemen who are perhaps members of other boards of directors, and at certain intervals these wise and philanthropic men are very apt to ask for an analysis of the pay-roll of their company. And when they see that a certain workman in their employ is earning $5 a day, they are naturally horror-stricken. "Why," they say, "our orders to that superintendent were that he was to pay the ruling wages which prevail around here; $2.50 a day is all any machinist ought to earn; it is horrible to think of a mere machinist with no education earning $5 a day; Mr. President, I move that our superintendent be instructed to see that the men in this establishment are paid no more than other machinists in other establishments. Why should we be spoiling the labor of this part of the country?" So Mr. Foreman, although he may be an honest man, and although he has encouraged those men to turn out that work, in many cases perhaps has actually made promises to them that if they increased their output their wages would not be cut, that man is forced by the board of directors to go back on his word, to cut down the piece-work price; he has to force those men to make twenty pieces for $2.50 a day where before they made ten pieces for $2.50 a day. Now the working people of this country are not fools; generally one cut of that sort is enough; two always are enough; and from that time forward a workman is nothing but a fool if he does not soldier to "beat the band," if he does not deliberately try to make the people around him believe that he is working as fast as

he can, while he is really doing a very ordinary day's work. And, gentlemen, that is our fault, not his, and not a thing are we doing as a whole to remedy that state of affairs.

It was precisely this condition which forced us to take the first step which led towards Scientific Management. I had had a war lasting some two or three years with the workmen who were my friends, over whom I was finally placed, a constant running fight for two or three years, in which I was trying to drive them in spite of their resistance to do a larger amount of work. Having worked with them, I knew they were soldiering to the extent of about two-thirds, and I hoped to be able to get them to at least double their work, and finally I did, and then they were one-third short of what they could have done. After three years of that fight, three years of never looking a man in the face from morning till night except as a tactical enemy, three years of wondering what that fellow was going to do to me next and wondering what I could do to him next, I made up my mind that some remedy would have to be devised for that state of things or I would cease to be a foreman and go into some other business. It was in an endeavor to remedy such a state of things that the first step was taken leading towards Scientific Management.

In taking account of stock, after I had definitely made up my mind either to try to remedy that state of things or get out of industrial management, I found that the chief lack was the lack of knowledge. I had no illusions as to my own knowledge; I knew that these workmen knew ten times as much collectively as I knew. And we started to take measures which should enable the foreman of that shop to know approximately what his men knew. We started then along various lines of study with the purpose of educating the owners and managers of the shops of the Midvale Steel Works so that they also should know approximately what their men knew. That was the first step leading towards Scientific Management.

I want to tell you as briefly as I can what Scientific Management is. It certainly is not what most people think it to be.

It is not a lot of efficiency expedients. It is not the printing and ruling of a lot of pieces of blank paper and spreading them by the ton about the country. It is not any particular system of paying men. It is not a system of figuring costs of manufacture. It is none of the ordinary devices which unfortunately are going by the name of Scientific Management. It may in its essence be said in the present state of industry to involve a complete mental revolution, both on the part of the management and of the men. It is a complete change in the mental attitude of both sides towards their respective duties and towards their opponents. That is what constitutes Scientific Management.

There are now, I don't know exactly how many, but at a fair estimate I should say 50,000 men working under Scientific Management. These men are on the average turning out twice as much work per man per day as they formerly did.

As a result of this increase in output, their employers are profiting by a very material reduction of the cost of whatever they are making. This diminution of cost has enabled them, on the one hand, to earn a larger profit and, on the other hand, in most cases to somewhat reduce the selling price of the goods which they make. And let me tell you, gentlemen, that in all cases of Scientific Management, in all cases of increase in efficiency, the general public takes almost the whole of the increase in the end. We consumers are the beneficiaries of the increase in output. The history of the matter shows that neither the manufacturer nor the workman through any long period gets very much benefit from increased output except as the whole world takes it. The world takes that benefit and is perfectly entitled to it. Now the workman: what have these 50,000 men who are working under Scientific Management got out of it? On an average those men are earning from 30 per cent to 100 per cent higher wages than they did, and I look upon that as perhaps the smallest part of their gain. Those workmen, to my mind, have gained something far greater than that; in place of looking

at their employers with suspicion, in place of looking upon them as at least tactical enemies although they may be personal friends, they look upon their employers as the very best friends they have in the world. I look at that as the greatest gain that can come under Scientific Management, far greater than any increase in wages. The harmony that exists between employer and employee under Scientific Management is the greatest gain that can come to both.

That is mere assertion, but in proof of the fact that this harmony does exist between the workman and the employers under Scientific Management, I wish to make the statement that until perhaps three months ago there never had been a single strike of men employed under Scientific Management. Even during the difficult period of changing from the old management to the new, that difficult and dangerous period when a mental revolution was taking place and causing readjustment of attitude towards their own duties and towards the duties of the management, there had never been a strike until this year. This system has been applied to a great number and variety of industries, and the fact that until recently there had never been a single strike is ample proof that these friendly relations actually exist between both sides. That, perhaps, is the most important characteristic of Scientific Management.

In order to explain what Scientific Management is, I want to present first what I believe all of you gentlemen will recognize as the best of the older types of management and to contrast with that type the principles of Scientific Management. If you have an establishment with 500 or 1,000 men, there will be, perhaps, twenty different trades represented. Each of the workmen in those trades has learned practically all he knows from watching other workmen. When he was a young apprentice he would watch a journeyman, imitate his motions, and finally perhaps the journeyman would get interested and turn around and give the boy a little friendly advice; and thus the boy, merely by personal observation and a very small amount of incidental teaching, learned the

trade. In just this way every operative in every one of those twenty different trades in your establishment has learned his trade; it has come to him just as it did in the Middle Ages, from mouth to mouth, or rather from hand to eye, not through teaching. Nevertheless, in spite of the old traditional way of learning a trade, this knowledge is the greatest asset that a workman possesses. It is his capital.

The manufacturer who has any intelligence must realize that his first duty should be to obtain the initiative of all these tradesmen who are working under him, to obtain their hard work, their good-will, their ingenuity, their determination to treat their employer's business as if it were their own. And in this connection I wish to strain the meaning of the word "initiative" to indicate all of those good qualities. It should be the first object of a good employer to obtain the real initiative of his workmen.

There is an occasional employer, possibly one in a hundred, who deliberately sets out to give his employees something better in the way of wages and opportunities than his competitors give their men. These very few rare employers who are farther sighted than the average, deliberately set out to give their men a special incentive, and in return they expect, and they frequently get, from their men an initiative which other employers do not dream of getting. However, this initiative is generally spasmodic. Workmen come to have confidence in their superintendent, or in their foreman, and in the honor of their company; and when the superintendent tells them that he intends to have them earn more money than other employers are paying their workmen, they believe it and respond in a generous way. But I want to tell what happens almost always, even in such a case: some new workman comes in for whom they have respect; he tells the men the usual story; that the same promise had been made to him or to friends of his in some other shop by a foreman, a square man, but it happened that that foreman died, or was replaced, or the board of directors did just what I outlined at the beginning, and then those promises went to the winds, and the

men found themselves working harder than before at the old wages. When a man comes in among them and tells them that story the men think, "Perhaps that is so, — it is likely to happen in our shop; I guess we had better not work too hard," and they slow down. Finally, as they think it over and realize that their foreman can be relied on, they say, "This fellow is all right, he can't treat us like that, we have got to be square," and eventually they will work hard again. But under the old system the initiative of the workmen is obtained spasmodically at best; it is rarely obtained to the fullest extent.

The first advantage which Scientific Management has over the older type is that under Scientific Management the initiative of the workmen is obtained with absolute regularity; their hard work, good-will and ingenuity are obtained with absolute regularity. I refer of course only to those cases in which Scientific Management is actually introduced and in operation, not where it has just been started; but in practically all cases where Scientific Management has been once established the initiative of the workmen is obtained with absolute regularity. That alone is a marked advantage of Scientific Management over the best of the other types.

This is not, however, the greatest advantage of Scientific Management. This is the lesser of two advantages. The greater advantage comes from the new and unheard-of burdens and duties which are assumed by the men in the management, duties which have never been performed before by the men on the management side. These new duties are divided into four large classes which have been, properly or improperly, called "The Four Principles of Scientific Management."

The first of these four great duties which are undertaken by the management is to deliberately gather in all of the rule-of-thumb knowledge which is possessed by all the twenty different kinds of tradesmen who are at work in the establishment, — knowledge which has never been recorded, which is in the heads, hands, and bodies, in the knack, skill, dexterity which these men possess — to gather that knowledge,

classify it, tabulate it, and in most cases reduce it to laws and rules; in many cases, work out mathematical formulæ which, when applied with the coöperation of the management to the work of the men, will lead to an enormous increase of the output of the workmen. That is the first of the four great principles of Scientific Management, the development of a science to replace the old rule-of-thumb knowledge of the workmen.

The second of the new duties assumed by the management is the scientific selection and then the progressive development of the workmen. The workmen are studied; it may seem preposterous, but they are studied just as machines have been studied in the past and are being more than ever studied. In the past we have given a great deal of study to machines and little to workmen, but under Scientific Management the workman becomes the subject of far more careful and accurate study than was ever given to machines. After we have studied the workman, so that we know his possibilities, we then proceed, as one friend to another, to try to develop every workman in our employ, so as to bring out his best faculties and to train him to do a higher, more interesting and more profitable class of work than he has done in the past. This is the second of the principles of Scientific Management.

The third duty is to bring the scientifically selected workman and the science together. They must *be brought* together; they will not come together without it. I do not wish for an instant to have any one think I have a poor opinion of a workman; far from it. I am merely stating a fact when I say that you may put your scientific methods before a workman all you are a mind to, and nine times out of ten he will do the same old way. Unless some one brings the science and the workman together, the workman will slip back as sure as fate into the same old ways, and will not practise the better, the scientific, method. When I say, make the workman do his work in accordance with the laws of science, I do not say *make* in an arbitrary sense. If I did it would apply far more to the employing than to the working class, because in the work of changing from the old to the new system, nine-tenths of

our troubles are concerned with those on the management side, and only one-tenth with the workmen. Those in the management are infinitely more stubborn, infinitely harder to make change their ways than are the workmen. So I want to qualify the word *make;* it has rather a hard sound. Some one must *inspire* the men to make the change, for it will not occur naturally. If you allow things to wait, it will not occur in ten years when it should occur in two months. Some one must take it in hand.

The fourth principle of Scientific Management is a little more difficult than the others to make clear. It is almost impossible to explain to the average man what I mean by it, until he sees one of our companies organized under Scientific Management.

The fourth principle is a deliberate division of the work which was formerly done by the workmen into two sections, one of which is handed over to the management. An immense mass of new duties is thrown on the management which formerly belonged to the workmen. And it is this handing of duties which they never dreamed of assuming before over to those on the management side, requiring coöperation between the management and the workmen, which accounts more than anything else for the fact that there has never been a strike under Scientific Management. If you and I are doing a piece of work together, and realize that we are mutually dependent upon one another, it is impossible for us to quarrel. We may quarrel, perhaps, during the first few days. Some men find it difficult to coöperate. But when they once get to going and see that the prosperity of both sides depends on each man doing his share of the work, what is there to strike about? They realize they cannot strike against the friend who is helping them. That is what it is, a case of helpfulness. I think I can say truthfully that under Scientific Management the managers are more the servants of the men than the men are the servants of the managers. I think I can say that the sense of obligation is greater on the part of the management than on the part of the men. They

have to do their share and be always ready. That is the feeling of those on the management side under Scientific Management.

In order to make that equal division a little clearer, I will say that in one of our machine shops, for instance where we do miscellaneous work, not work that is repeated over and over again, there will be at least one man on the management side for every three workmen throughout the whole establishment. That indicates a real division of work between the two sides. And those men on the management side are busy, just as busy as the workmen, and far more profitably busy than they were before.

Let me repeat briefly these four principles of Scientific Management. I want you to see these four principles plainly as the essence of the illustration I am going to give you of Scientific Management. They are the development of a science to replace the old rule-of-thumb methods; the scientific selection and then the progressive teaching and development of the workmen; the bringing of the scientifically selected workmen and the science together; and then this almost equal division of the work between the management and the men.

I wish to convince you of the importance of these principles. So far what I have said has been mere assertion. The only means that I have of convincing you of the value of these principles is to give illustrations of their application. But I fear my time is too short to give more than two or three.

I usually begin with the most elementary kind of labor that I know, and try to show the immense power of those four principles when applied even to that extraordinarily elementary form of labor. The simplest kind of work that I know is handling pig iron. A man stoops down to the ground or a pile, picks up with his hands a piece of pig iron weighing usually about ninety pounds, walks a certain number of steps and drops it on a pile or on the ground. I dare say that it seems preposterous to you to say that there is any such thing as the science of handling pig iron, that there is any

such thing as the training of a workman and the coöperation and the equal division of the work between the two sides in handling pig iron. It seems absolutely preposterous. But I assure you that had I time I could convince every one of you that there is a great science in handling pig iron. It takes a little too long to give that particular illustration, and I very much regret that I must begin with a form of labor which is far more scientific than handling pig iron, namely, shoveling dirt.

I dare say that you think there is no science in shoveling dirt, that any one can shovel dirt. "Why," you say, "to shovel it you just shovel, that is all there is to it." Those who have had anything to do with Scientific Management realize, however, that *there is a best way in doing everything*, and that that best way can always be formulated into certain rules; that you can get your knowledge away from the old chaotic rule-of-thumb knowledge into organized knowledge. And if any one of you should start to find the most important element in the science of shoveling, every one of you with a day's or two days' thought would be on the track of finding it. You would not find it in a day, but you would know what to look for. We found it after we started to think on the subject of shoveling. And what is it? There are very many elements, but I want to call your attention to this important one. At what shovel-load will a man do his biggest day's work? There must be some best shovel-load; what is it?

The workers of the Bethlehem Steel Company, for instance, almost all owned their own shovels, and I have seen them go day after day to the same shovel for every kind of work, from shoveling rice coal, three and a half pounds to a shovel-load, to shoveling heavy wet ore, about thirty-eight pounds to the shovel-load. Is three and a half pounds right or is thirty-eight pounds right? Now the moment the question "What is the proper shovel-load?" is asked under Scientific Management, it does not become the duty of the manager to ask some one, to ask any shoveler, what is the best. The old style was, "John, how much ought you to take on your

shovel?" Under Scientific Management it is the duty of the management to *know* what is the best, not to take what some one thinks. We selected two first-class shovelers. Never examine any one but a first-class man. By first-class I do not mean something impossible to get, or even difficult to get. Very few people know what you mean when you say first-class. I think I can explain it to you better by talking about something with which we are all familiar. We know mighty little about men, but there is hardly one of us here who does not know a good deal about horses, because we are in the habit of studying horses. Now if you have a stable full of horses containing large dray horses, carriage horses, saddle horses and so on, and want to pick a first-class horse for hauling a coal wagon, I know every one of you here would take the dray horse. I do not believe any of you would take the trotting horse and call him first-class at all. That is what I mean when I say *first-class man.* If you have a very small stable, when you have a good deal of coal to haul you may have to hitch your trotting horse to a light grocery wagon or even to your buggy to haul coal. But that is not a first-class horse for the purpose, and no one would think of studying a trotting horse hauling a buggy of coal to find what a first-class horse should do in hauling coal. There are many people who say, "You are looking for impossible people; you are setting a pace that nobody can live up to." Not at all. We are taking the man adapted to the work we wish done.

So when we wanted to study the science of shoveling we took two men and said, "You are good shovelers; we want you to work squarely. We are going to ask you to do a lot of fool things, and we are going to pay you double wages while this investigation is going on. It will probably last two or three months. This man will be over you all day long with a stop-watch. He will time you; he will count the shovel-loads and tell you what to do. He does not want you to hurry; just go at your ordinary fair pace. But if either of you fellows tries to soldier on us, that will be the

end of it; we will find you out as sure as you are born, and we will fire you out of this place. All we want is a square day's work; no soldiering. If you don't want to take that job, don't, but if you do we are very glad to pay you double wages while you are doing it." These men said they would be very glad to do it, and they were perfectly square; they were ready to do a fair day's work. That was all we asked of them, not something that would tire them out or exhaust them, but something they could live under forty years and be all right.

We began by taking the maximum load on the shovel and counting the shovelfuls all day long and weighing the tonnage at the end of the day. I think it was about thirty-eight pounds to the shovel. We found how much those men could do when they were shoveling at thirty-eight pounds to the shovel on an average. And then we got shorter shovels holding about thirty-four pounds, and measured the tonnage per day, and it was greater than when they were using the thirty-eight pound shovel. They shoveled more with the thirty-four pound shovel-loads than with the thirty-eight pound shovel-loads. Again we reduced the load to thirty pounds and they did a still greater tonnage; again to twenty-eight pounds, and another increase; and the load kept on increasing as we diminished the shovel-load until we reached about twenty-one pounds; at twenty-one pounds the man did his biggest day's work. With twenty pounds, with eighteen pounds, with seventeen, and with fourteen, they did again a smaller day's work. Starting with a thirty-eight pound shovel, they went higher and higher until the biggest day's work was done with a twenty-one pound shovel; but when they got the lighter shovel the load went down as the shovel-load diminished.

The foundation of that part of the science of shoveling, then, lies in always giving a shoveler a shovel which will hold twenty-one pounds, whatever the material he is using.

What were the consequences of that? In the Bethlehem Steel Works we had to build a shovel-room for our common

laborers. Up to that time the men had owned their own shovels. We had to equip this room with eight or ten different kinds of shovels, so that whatever the man went at, whether rice coal on the one hand, or very heavy ore on the other, he would have just a twenty-one pound load. That meant organization in place of no organization.

It meant also arranging that each one of the laborers in that yard had the right shovel every day for the kind of material he was going to work on. That required more organization. In place of the old-fashioned foreman who walked around with his men to work with them, telling them what to do, it meant the building of a large, elaborate labor office where three college men worked, besides their clerks and assistants, planning the work for each of these workmen at least one day in advance. That yard was about two miles long and half a mile wide; you cannot scatter 500 to 600 men over a space of that size, doing all kinds of miscellaneous work, and get the man, the shovel and the other implements, and the work together at the right time unless you have an organization. It meant, then, building a big labor office and playing a game of chess one day in advance with these 500 men, locating them just as you would locate chessmen on your board. It required a time-table and a knowledge of how long it took them to do each kind of work.

It meant also informing the men each day just what they had done the day before and just what they were to do that day. In order to do that, as each man came in the morning he had to reach his hand up to a pigeonhole (most of them could not read and write, but they could all find their pigeonholes) and take out two slips of paper. One was a yellow slip and one was a white slip. If they found the yellow slip, those men who could not read and write knew perfectly well what it meant; it was just the general information: "Yesterday you did not earn the money that a first-class man ought to earn. We want you to earn at least 60 per cent beyond what other laborers are paid around Bethlehem.

You failed to earn that much yesterday; there is something wrong." It is merely a notice to the man that there is something wrong. The other piece of paper told him what implement to use. He went to the tool-room, presented it, received the proper implement, and took it down to the part of the yard in which he was to work.

When any of these workmen fell down for three or four days in succession, the old way would be to call him up and say, "Here, John, you are no good; get out of this; you are not doing a day's work. I don't have any man here who is not doing a day's work. Now get out of this." But that is not the way with Scientific Management. The moment the management sees that this man has fallen down, that it is something more than an accident, then a teacher — not a bulldozer, but a *teacher* — is sent out to him to find out what is the matter, and to study the man for the purpose of correcting his fault. In nine cases out of ten that teacher would perhaps find that the man had simply forgotten something about the art of shoveling. I suppose you are skeptical about this "art of shoveling," but let me tell you there is a great deal to it. We have found that the most efficient method of shoveling is to put your right arm down on your right hip, hold your shovel on your left leg, and when you shovel into the pile throw the weight of your body upon the shovel. It does not take any muscle to do that; the weight of your body throws it if you get your arm braced. But if you attempt to do as most shovelers do, take it with your arms and shove into a stubborn pile, you are wasting a great deal of effort. Time and again we found that a man had forgotten his instructions and was throwing the weight of his arms instead of the weight of his body. The teacher would go to him and say, "You have forgotten what I told you about shoveling; I don't wonder you are not getting your premium; you ought to be getting 60 per cent more money. You are falling out of the first class. Now I want to show you again. Just watch the way this thing is done." The teacher would stand by him *as a friend* and show him how to earn his

premium. Or perhaps if he found that the man was really not suited to that work, for instance that he was too light for it, the man would then be transferred to a lighter kind of work for which he was suited. It is in that way, by kindly and intimate personal study of them, that we find to what workmen are adapted.

All of that takes money, and it is an important and very fair question whether it pays. Can you pay for all these time-study men who are developing the art of shoveling? Can you pay for your shovel tool-room, for the telephone system and all the clerks and teachers? The only answer to that is these facts. At the end of about three years we had practically the whole of the yard labor of the Bethlehem Steel Works transferred from the old piece-work and day-work plan to the new scientific plan. Those workmen under the old plan had earned $1.15 a day. Under the new plan they earned $1.85 a day, an increase of more than 60 per cent in wages. We had them studied and a report made. We found that they were practically all sober, that most of them were saving some little money, that they lived better than they ever had before, and that they were as contented a set of men as could be found together anywhere, a magnificent body of carefully selected men. That is what the men got out of it.

What did the company get out of it? The old cost for handling a ton of materials in the yard of the Bethlehem Steel Company was between seven and eight cents a ton. The new cost, after all the costs of the clerical work in the office and the tool-room, of the teaching, the telephone system, the new implements and the higher wages, were taken into consideration, was between three and four cents a ton. And the actual cash saving to the Bethlehem Steel Company during the last year was between $70,000 and $80,000. That is what the company got out of it, and therefore the system is justified from the points of view both of the men and of the management.

I am very sure that I could convince you that the ratio

of gain of Scientific Management when applied to a trade that requires a high-class mechanic, is far greater than when applied to work like shoveling. The difficulty which I find is to convince men of the universality of these principles, that *they are applicable to all kinds of human effort.* I should like to convince you, I am sure that I could convince you, that with *any* of the more intricate kinds of work, the gain must be enormously greater than with the simple work; that no high-class mechanic can possibly do what he should for his own sake and for the employer's sake, without the friendly coöperation of a man on the management side. That is what I should like to prove to you, prove beyond the shadow of a doubt.

Take the case of a machinist who is doing work that is repeated, we will say, over and over again. He is not the highest class mechanic, but he is fairly well up. It may be questioned whether it is possible for any scientific knowledge to help an intelligent mechanic, a man, for instance, who has had a high school education and who has worked for his whole life as a machinist. I want to show you that that man needs the help of — not a higher order of man, nothing of that sort, but of a man with a different type of education from his own; that the skilled workman needs it far more even than the cheap laborer needs it in order to do his work right.

I take an actual case, that of a shop manufacturing small machines. This was a department of a large company which had been running under the old system many years. The article was a patented device that had been manufactured in this department about twelve years, perhaps more, by some 300 workmen. These articles varied somewhat in size but they were made by the thousands. The men would naturally become highly skilled. Each man had his own machine, ran it from year end to year end, made comparatively few parts, and therefore became skilled in his work.

Now the owner of this establishment was a very progressive man, and he came to the conclusion that he wanted to investigate Scientific Management. So he sent for my friend,

Mr. Barth, to see what Mr. Barth could do for him. After they had had a little sparring on the subject, Mr. Barth rather mortified the owner by telling him that he could come pretty close to doubling the output of his shop. After they had sparred a little over that, Mr. Barth suggested that he make a test to show the men in the shop what he could do. So a typical machine was selected, a machine which they both agreed was fairly representative of the machines in the shop, and the work which was then being done noted; the kind of work, the character of it and the time which it should take to do it was written down. Then Mr. Barth proceeded to study the machine, in just the way under Scientific Management all machines are analyzed in all shops that we go to. We do not go to some foreman or superintendent, or to the maker of the machine, and ask, "How fast do you think we should run this machine?" Not at all. A careful, thorough analysis was made of the possibilities of that machine, and to do that Mr. Barth used four slide-rules. One slide-rule will solve any problem in gearing in almost no time. It is a gear slide-rule. Another solves any problem about belts in a fraction of a minute. Another tells you how many pounds pressure a chip of any shape or kind will exert on the cutting tool, and therefore shows you how much resistance you have to overcome with your machine. The fourth slide-rule tells you what cutting-speed you can use with any kind of metal, with any depth of cut, with any feed and with any shape tool.

Now with these four rules it is possible scientifically to analyze the machine, to know how it should be speeded for the particular kind of work that is in hand. And let me tell you — this may seem an extraordinary statement — let me tell you that there is not one machine in fifty in the average machine shop in this country that is speeded right. I say that with all confidence. I say it with perfect confidence, because last spring I was invited by the tool builders, the makers of these machines, to address them at their annual meeting, and I challenged them to contradict that fact.

They were there, representatives of the tool builders of this country, and not one man took up my challenge. They knew, just as well as I know, that their speeds are nine-tenths guess and one-tenth knowledge, that they do not take into consideration the peculiarities of the shop their machines go into, in one case in fifty. They have no means of knowing the kind of material the machines are to cut, and the machines are speeded practically the same for every shop they go to, whereas each machine should be speeded to suit the average of the work that is to be done in a particular shop.

After Mr. Barth had inspected that machine by means of these slide-rules, in two or three hours he was able to write the prescription for it, showing what should be done to have it right. And then, after he had given directions to have the machine speeded right, he went home and made a slide-rule by means of which, when he returned to the shop, he was able to show the workmen, the foreman, and the owner of that shop just how the machine should be run in various cases. Pieces of metal were put into the machine, similar to those which were ordinarily run in it, and his smallest gain was two and a half times as much, and his largest gain nine times as much work as had been done before. That is typical of what can be done in the average machine shop in this country.

Why? Because the science of cutting metals is a true science, and because the machine shops of this country are run, we can almost say, without the slightest reference to that science. They are run by the old rule-of-thumb method just as they were fifty years ago. The science is almost neglected, and yet it is true science.

I want to show you in a general way what that science is, so that you will understand why it is that a man who had never seen that particular machine, who had never seen that work, was able to compete with the workman who had been working for ten or twelve years on the same machine, who had the help of the foreman and of his superintendent, — for it was a well-run establishment; how a man who had

never seen that work, but who was equipped with a knowledge of the science, was able to make it do from two and a half to nine times as much work as had been done before. I want to show you what it is, because that is the essence of Scientific Management, the development of a science which is of real use when applied with the coöperation of the management to help the workmen.

I spoke at the beginning about an ordinary piece-work fight which went on between a foreman who tried to do his duty and his men. At the end of that bitter fight of two or three years, I obtained permission from William Sellers, who was then the president of the Midvale Steel Works, to spend some money in educating the foreman of the Midvale Steel Works so that he should have at least a fraction of the knowledge of his men. And one of the subjects which we took up at that time, one in which the foreman needed most education, was the science of cutting metals, for metal-cutting was the whole work of the shop. And I believed, just as Mr. Sellers believed, just as almost every mechanic at that time believed, that the science of cutting metals consisted mainly if not entirely in finding the proper cutting angles of the tool.

As you all know, each metal-cutting tool has, properly speaking, three cutting angles. It has the clearance angle, the side slope and the back slope. And it was my opinion, just as it was the opinion of almost every machinist that I knew, that if you could get the right combination of cutting angles you could cut steel and iron a great deal faster than we were then doing. So we started out to make a careful investigation as to what those cutting angles should be.

We were exceedingly fortunate in having what hardly any shop in the United States had at that time, a very large boring room. We were then making locomotive tires. That was a considerable part of the business of the Midvale Steel Works at that time. We had a very large boring mill available, sixty-six inches in diameter, and a very large uniform body of metal and tires weighing 2,000 pounds to put on it. So we had an opportunity to do what very few

people had the opportunity to do. A sixty-six-inch diameter mill was at that time an unusually large one, so we put our tire on that mill and, having enough metal in that one piece to run three or four months, we could eliminate possible errors resulting from variability of the metal. At the end of six months we found that these angles which we supposed were of the greatest consequence counted for but little in the art of cutting metals. The two things which every machinist must know every time he puts a piece of work into his lathe, if he wishes to do it right, are the speed he should run his machine and the feed he should use in order to do his fastest work. Those two things sound very simple indeed. But to know them is to know the science of cutting metals. At the end of six months we found that the thing we were hunting for, the question of angles, had very little bearing on the problem, but we had unearthed a gold mine of possible information. And when I was able to show Mr. Sellers the possibilities of knowledge ahead, he said at once, "Go right ahead, go on spending the money." And for practically twenty-six years, with here and there a year or two of intermission, went on that series of experiments to determine the laws of the science of cutting metals. It was found that there were twelve great variable elements which enter into metal-cutting operations. All that was done in twenty-six years was to investigate these twelve elements, to find out the facts connected with them, to record and tabulate these facts, to reduce them to mathematical formulæ, and finally to make those mathematical formulæ applicable in everyday work.

I know that it will seem almost inconceivable that such a time should be taken, and I want to show you how it is possible that it took that length of time. At various times in this investigation ten different machines were built and equipped and run for the purpose of determining the various elements of this science. While we were at the Midvale Steel Works we had no trouble at all, because they knew the value of the elements which we were studying; they knew the commercial value of them; but after we left there our

only means of continuing these experiments was to give the information which we had up to date in payment to any one who would build us a machine and furnish the labor and materials to continue the investigation. So most of these ten different machines were built in that way by men who were willing and anxious to trade their money, in the shape of new equipment, new forgings, new castings, and new labor, for the knowledge that had been obtained from previous experiments.

Let me briefly call your attention to some of the variable elements. I will not bother you with all the twelve, but I want to let you see enough of them to appreciate what I mean by this science of cutting metals. Investigations similar to this are bound to be made in every industry in this country, scientific investigations of those elements which go to make up the science, whatever that science is; that is the reason why I am dwelling on it. It is not an isolated case. It is perhaps the longest-drawn-out investigation that has been made, but it is simply typical of what is bound to take place in every industry.

One of the first discoveries which we made — and it seems an exceedingly simple one — was that if you throw a stream of water on the chip and tool at the point at which the shaving of iron is being cut off from the forging, you can increase your cutting speed 40 per cent. You have a 40 per cent gain just by doing that little thing alone. That we found out within the first six months. Mr. Sellers had the courage of his convictions; he did not believe it at first, but when we proved to him that it was true, he tore down the old shop and replaced it with another so as to get that 40 per cent increase in the cutting speed. He built a shop with water drains extending under the floor to carry off the water with which the tools were cooled to a central settling tank; from there it was pumped up again to a tank in the roof and carried from there through proper piping to every tool, so that the workman did not need to spend much time in adjusting a stream which would flow on to any tool in any position. He

was a broad enough man to see that it paid him to build a new shop to get that 40 per cent.

Now our competitors came right to the Midvale Steel Works without any hesitation. They were invited to come there, and in twenty years just one competitor used that knowledge and built a shop in which it was possible to throw a heavy stream of water on the tools, and that was a shop started by men who had left the Midvale Steel Works and who knew enough to do this. That shows the slowness of men, in that trade at least, to take advantage of a 40 per cent gain in cutting.

That is one of the twelve elements, a very simple one, the simplest of all. Let me show you one or two more.

There is the old diamond-point tool, used when I was a boy in practically all shops throughout the country. One of the first suggestions that I had for an experiment was from Mr. John Bancroft, now one of the ablest engineers in the country. He suggested that I try the effect of using a round-nose tool, with a round cutting-edge. Hardly a single piece of original work was done by us in Scientific Management. Everything that we have has come from the suggestion of some one else. There is no originality about Scientific Management. And, gentlemen, I am proud of it; I am not ashamed of it, because the man who thinks he can place his originality against the world's evolution, against the combined knowledge of the world, is pretty poor stuff.

Now, that diamond-point tool was almost universally used at that time, and I do not believe there is one mechanic in fifty now who knows why it was used. It was used because in the primitive shops, such as the one in which I served my apprenticeship, we all had to make and dress our own tools. There was no tool dresser. We would heat the metal, lay it on the edge of the anvil one way and ask a friend to hit it a crack, and then turn it around and repeat the process, and simply turning it and hitting it with the sledge would give it the diamond point. That is the only reason why a tool of that shape was in use. It was a tradition. It had no scientific basis.

After a sufficient number of experiments, we found that a round-nose tool was far superior to a diamond-point tool, but it took a long time after we made that discovery before we found what kind of a round-nose tool. It took years before we were through with the experiment to determine what curve was the best when all things were considered, because there are many considerations which come in. There is the speed, the convenience of handling, the kind of work to be done, and so on.

Having, then, decided that a round-nose tool was the best, we had to make another investigation. If you have a light cut taken on your tool in one case, a heavy cut in another, and a still heavier one in another, it is a matter of plain common sense that you could of course in one case run a very much higher cutting-speed than in another. How fast can you run? That is a question for accurate scientific investigation. The investigation, simply to determine that fact, took altogether, I think, as much as two years. And even after we had determined the facts, it was many years before we finally got the proper mathematical expression of those facts. That is a totally different matter. Before we had reduced our knowledge to a true mathematical formula which could be worked with, it was a question of years.

The next investigation, perhaps the most spectacular of all, was to answer the question, what is the effect of the chemical composition of the tool and its best treatment? The old-fashioned tools when I served my apprenticeship were all made of carbon steel. But it has been found that by putting tungsten in those tools one can make them withstand a higher amount of heat and still not lose their cutting-edge. A part, then, of the study of the art or science of cutting metals was to make a thorough, scientific investigation of the possibilities of alloy steel, not only with the new metal tungsten, but with other alloys which presented possibilities; so we varied the quantities of tungsten, chromium, molybdenum and one or two other elements, until at the end of three years of continuous experimenting the modern high-

speed steel was developed; that is, a certain kind of steel which when heated in a certain revolutionary way would enable you to run, to be accurate, just seven times as fast as with the carbon steel. The discovery of high-speed steel and its treatment was the result of investigations. Most people think it was a mere accident, that some fools were fooling around and by accident discovered this thing; but I assure you three or four years of hard study and investigation by chemists and metallurgists working according to the most scientific methods were required. In these various experiments $200,000 were spent and from 800,000 to 1,000,000 pounds of metal were cut up into chips.

Perhaps the most difficult phase of the experiments was getting steel of uniform hardness for experimental purposes. To carry on our elaborate experiments when high-speed steel came in, we had to have at least 20,000 pounds of metal to experiment on, and it is almost impossible to get 20,000 pounds which are uniform. We finally solved it and obtained metal which was sufficiently uniform by using exactly the same processes which are used in making the great high-power cannon for the army and navy. That is, we forged metal under a forging-press, and then oil-tempered and annealed it until we got a uniform body of metal. The tempering and annealing resulted in making the steel finer and finer and making all the crystallized structure uniform.

I want to explain why twenty-six years were necessary to carry out these experiments. Time after time we would have to throw away six months' work because eleven of these elements had slipped up while we were experimenting with the twelfth. If hard spots appeared in the steel, a whole line of experiments was thrown out and we would have to get a new forging and start all over again. It was the difficulty of that sort of thing, holding eleven elements constant while we were getting the twelfth, which made that problem as difficult as it was. When those experiments had first been reduced to facts, and then the facts to diagrams, and then curves drawn through the diagrams and finally mathe-

matical formulæ made to fit those diagrams, then we were on the road towards the development of a science. We finally developed twelve formulæ to represent the twelve variables, of which this is a specimen:

$$V = \frac{11.9}{F^{0.665}\left(\frac{48}{3}D\right)^{0.2373+\frac{2.4}{18+48D}}}$$

When one has a lot of mathematical formulæ of that sort, it seems at first the idea of a lunatic to imagine that any one could get any use out of them. That is, all of our friends, when they found that our experiments were resulting in such formulæ as these, said, "Why, you are nothing but rank crazy; you will never be able to use these things." And a great work, greater than the experiments which gave us these formulæ, was the work of giving these formulæ a form which would make them usable for the ordinary machinist. We kept mathematicians working on that problem for about eighteen years.

Now you must realize that a mathematical problem with twelve variables is a big thing. During that time we went to the great mathematicians in the country, the professors in our universities, and offered them any price to solve that problem for us. Not one of them would touch it; they all said, "You can solve a problem with four variables if you have your four equations, possibly; beyond that it is an indeterminate problem, and it is all nonsense thinking of getting a mathematical solution for it." I dare say you people think I am trying to prove that Mr. Barth and Mr. Gantt and these other gentlemen are very remarkable men. Nothing of the kind. This is the point I want to make: that it is a long, tedious operation to solve a problem of that sort, or to solve any of the intricate problems connected with the mechanic arts, or those that are going to arise in any art. It is a difficult thing to do. But very ordinary men with ordinary equipment can solve and make useful any problem, I do not care how difficult it is, if they will only give the time and the money and the patience; they will solve it.

At the end of eighteen years these men had devised a little machine, a slide-rule, which solves the problem with twelve independent variables in about twenty seconds. That is put into the hands of an ordinary lathe man who knows nothing about mathematics, and by means of it that man determines under which one of 800 or 900 conditions pertaining to the particular job he will do his fastest work. It was for that reason that Mr. Barth, with his slide-rule, was able to more than compete with the mechanic who had spent twelve years in the old-fashioned rule-of-thumb way of cutting a particular kind of metal on his particular kind of machine; just for that reason, because the amount of knowledge which that machinist needed to have in order to solve that problem was utterly impossible for any one to have.

What I am trying to show you is, that the more intelligent the high-class mechanic the more he needs the help of the man with the theoretical knowledge; he must have it even more than the ordinary laborer must have it. And that is why this coöperation, in which the management does one part of the work and the workman another, must accomplish overwhelmingly more work in all cases than the old method of leaving to the workman both the determining how and the performance.

There is just one thing more that I want to say; something that I am sure you are all thinking of. I find this question in the mind of every one who is considering Scientific Management. It may be that this combination of the science and the workman turns out more work than before, but doesn't it make a wooden man out of the workman? Doesn't it make him a machine? Doesn't it reduce him to the level of an implement?

I want to give one or two answers to that. The first is this: that under the new system every single workingman is raised up, is developed, is taught, so that he can do a higher, a better, and a more interesting class of work than he could before. The ordinary laborer is taught to run the

drill-press in the machine shop; the drill-press hand becomes a lathe hand; the lathe hand becomes a tool maker, the tool maker — now I am speaking of types of men, you understand, not literally — the tool maker becomes one of the teachers. He is the man in the planning room. He is the man who makes up this one out of three who is transferred to the management side, so that the best workmen, who before would have remained workmen, are on the management side and become teachers and helpers of the other workmen. I want to emphasize the brotherly feeling which exists under Scientific Management. It is no longer a case of master and men, as under the old system, but it is a case of one friend helping another and each fellow doing the kind of work that he is best fitted for. You boys have here in the college one pretty good piece of Scientific Management, and that is football, — a good case of coöperation, training and teaching, and that is the fine feature about football, that it does enforce a fine method of friendly coöperation.

Does this make workmen into wooden men? Let us answer the second question. I have said, and I repeat, that no one claims any originality for Scientific Management; it was all done before. I do not know of a person who claims any originality for it whatever. It has simply taken what other people were doing before. Long before we had any development of Scientific Management, there was in existence a far finer case of Scientific Management than we have ever succeeded in developing. The finest mechanic in the world had developed Scientific Management long before we touched it or ever dreamed of it. You all know him, every one of you; he is the modern surgeon. In his operations five or six men coöperate, each one doing in turn just what he should do. How does that finest mechanic teach his apprentices? Do you suppose that when the young surgeons come to their teachers, the skilled surgeons, they are told first of all: "Now, boys, what we want first is your initiative; we want you to use your brains and originality to develop the best methods of doing surgical work. Of course you know we do have our

own ways of performing these operations, but don't let that hamper you for one instant in your work. What we want is your originality and your initiative. Of course you know, for example, when we are amputating a leg and come to the bone, we take a saw and cut the bone off. Don't let that disturb you for a minute; if you like it better, take an axe, take a hatchet, anything you please; what we want is originality. What we want of all things is originality on your part."

Now that surgeon says to his apprentices just what we say to our apprentices under Scientific Management. He says: "Not on your life. We want your originality, but we want you to invent upward and not downward. We do not want any of your originality until you know the best method of doing work that we know, the best method that is now known to modern surgery. So you just get busy and learn the best method that is known to date under modern surgery; then, when you have got to the top by the present method, invent upward; then use your originality."

That is exactly what we say to our men. We say, "We do not know the best; we are sure that within two or three years a better method will be developed than we know of; but what we know is the result of a long series of experiments and careful study of every element connected with shop practice; these standards that lie before you are the results of these studies. We ask you to learn how to use these standards as they are, and after that, the moment any man sees an improved standard, a better way of doing anything than we are doing, come to us with it; your suggestion will not only be welcome but we will join you in making a carefully tried experiment, which will satisfy both you and us and any other man that your improvement is or is not better than anything before. If that experiment shows that your method is better than ours, your method will become our method and every one of us will adopt that method until somebody gets a better one."

In that way you are able to apply a true science to mechanical work, and only in that way. If you allow each man to

do his own way, just exactly as he pleases, without any regard to science, science melts right away. You must have standards. We get some of our greatest improvements from the workmen in that way. The workmen, instead of holding back, are eager to make suggestions. When one is adopted it is named after the man who suggested it, and he is given a premium for having developed a new standard. So in that way we get the finest kind of team work, we have true coöperation, and our method, instead of inventing things that were out of date forty years ago, leads on always to something better than has been known before.

# Second Session

## FRIDAY FORENOON, OCTOBER THE THIRTEENTH

CHAIRMAN, BENJAMIN A. KIMBALL

*President of the Concord and Montreal Railroad, and President of The Mechanicks National Bank, Concord, N. H.*

# SCIENTIFIC MANAGEMENT AND THE LABORER

## INTRODUCTION BY THE CHAIRMAN

GENTLEMEN OF THIS CONFERENCE AND INVITED GUESTS:

WE had hoped to have with us to preside at this session of the conference, Mr. Edward Tuck, of Paris and New York, founder of the Amos Tuck School of Administration and Finance. Pressing engagements prevented Mr. Tuck's attendance here, and I have been requested to fill his place so far as I am able.

It is most fitting that this, the first organized conference on the question of Scientific Management, should be held in the halls of Dartmouth, whose history is linked so intimately with the development of this nation. The decision in the famous Dartmouth College case, rendered by the Supreme Court of the United States more than ninety years ago, established a precedent under which the modern corporation has developed, and, whatever the evils that have attended the growth of those great corporations, they have been instruments of incalculable value in securing coöperation in the commercial and industrial development of the United States. The name of Dartmouth College has therefore been closely identified with the firm establishment of the idea of nationality and the preservation of the Union, and with it the amazing prosperity of the country.

It now appears that one of the great questions facing the progressive business manager of today, and the question to which every manufacturer and financier of industrial and corporate management must give close study and attention, is that of more economical production; and we are assembled

here to consider a phase of this great problem. In our consideration of the principles of Scientific Management, we must not overlook the status of the employee. I take great pleasure in introducing to you Mr. Henry L. Gantt, Consulting Engineer, of New York City, who will adress us upon "The Task and The Day's Work."

## THE TASK AND THE DAY'S WORK

By HENRY L. GANTT
*Consulting Engineer, New York*

MR. CHAIRMAN, LADIES AND GENTLEMEN:

IT is very important that we have a clear general understanding of the subject before going into details, and I wish to refer to a point brought out by Mr. Taylor last night; namely, that the work we are doing *has not as its aim the development of a series of expedients to promote efficiency. We are trying as far as we can to solve the industrial problem*, which is the greatest problem before the country today. In this connection, I wish to say that the circular announcing this conference referred to several of us who were to speak as "efficiency engineers." To me the term "engineer" has always stood for a man whose business it is to utilize efficiently the materials and forces of nature; and such was the conception of the late Dr. R. H. Thurston, who for many years was one of the leaders of engineering thought in this country. As first president of the American Society of Mechanical Engineers, as Professor of Engineering at Stevens Institute, and later as Director of Sibley College — the great engineering school of Cornell University — he continually gave expression to this idea. Having been brought up in that school, I cannot accept for myself the title "Efficiency Engineer," as it seems to imply that there are engineers who are not striving for the promotion of efficiency.

The fact that, until recently, the engineer has confined his efforts to inanimate forces and materials does not seem to me to justify an extension of title when he includes in his work the promotion of efficiency in the field of human effort. While my feeling on this subject is very strong, it is necessarily only my personal feeling, and there may be others who have a different conception of the functions of the engineer. Such people are, of course, equally entitled to their own opinions on this subject.

About fifteen years ago, the financiers of this country discovered a new and seemingly important principle. They realized that, in many cases at least, large factories were making a greater percentage of profit than small ones, and conceived the idea of uniting the small ones under one system of management. By this move they certainly did give the small factories a better financial standing, at the same time reducing what might be called the financial, or business, expense.

By this they also reduced competition and decreased the cost of selling, which has always been a large element of expense. Under those conditions business prospered rapidly, for there was in many cases undoubtedly a reduction in cost. The illustrated magazines were filled with portraits of the *captains of industry* who had effected these combinations, and it was freely predicted that the economies to be obtained were so great that it would be a question of time only before Europe would be flooded with American goods.

The formation of consolidations, or *trusts*, in manufacturing, and of great *systems* in railroading, went on at a rapid rate. The economies that were produced by these methods, together with the fact that by the elimination of competition selling prices were kept up, enabled many such combinations to pay dividends on stock which had originally represented little or no value.

The unprecedented prosperity which followed the introduction of these methods was undoubtedly caused in a large measure by them, and the financier was justly regarded as

having done much to promote the prosperity of the country. Our internal trade grew at an astounding rate, but the American invasion of Europe did not materialize; and it was not very long before we began to hear complaints of the increasing *inefficiency of labor.* Wages began to rise, but the output of the workman did not rise correspondingly. The financier had undoubtedly effected economies in those parts of business directly under his control, but had not succeeded in producing a similar effect on those with which he did not come in direct contact.

As a matter of fact, while the financier had been forming his great combinations of manufacturing interests and railroads, with the effect, at least as far as the public was concerned, of upholding prices, the workmen had gone him one better. By their unions not only have they upheld the price of their labor, but in many cases markedly increased it, without rendering any more service than formerly; the employers, in many cases, say less.

Under these conditions, the projected invasion of Europe seems to have been postponed indefinitely, and the continually increasing cost of living in this country seems to indicate that we need something more than able financiering to round out our theory of *Industrial Economy.* While this fact is recognized by all, it is not so easy to specify exactly what is wrong or how it is to be corrected. Coöperation among employers to uphold the prices of their products has been so successful, that it is scarcely to be wondered at that the workmen should adopt the same tactics.

On this subject, Adam Smith, in his famous book, *An Inquiry into the Nature and Causes of the Wealth of Nations,* nearly 140 years ago wrote as follows:

"Our merchants and master-manufacturers complain much of the bad effects of high wages in raising the price, and thereby lessening the sale of goods at home and abroad. They say nothing concerning the bad effects of high profits. They are silent with regard to the pernicious effect of their own gains. They complain only of those of other people."

This statement made so long ago is just as applicable to the conditions of today, and admonishes us in approaching our problem to do so with an open mind and not from a partizan standpoint, for a solution cannot be permanent if it benefits one class exclusively.

Relative to the *increasing inefficiency of labor*, while the manager cannot be held responsible for the inefficiency he finds, he certainly is responsible if he allows it to increase. It therefore seems that the problem before us is one of management, and if the methods now generally in vogue do not accomplish the desired result, they must be modified; and our inquiry must be directed towards finding if possible some indication as to the form this modification must take.

THE TASK IDEA. In studying a problem it is best to consider first the simplest form in which that problem presents itself, and one if possible in which the issues are perfectly clear to all. A good example for our purpose is to study the methods by which a child is taught to perform a simple operation. The invariable method is to explain to the child as clearly as possible what is wanted, and then to set a task for it to accomplish. It may be noted that the accomplishment of the task is rendered much easier for both the child and the parent, if a suitable reward is offered for the proper performance. As a matter of fact, setting tasks and rewarding performance is the standard method of teaching and training children. The schoolmaster invariably sets tasks, and, while they are not always performed as well as he wishes, he gets far more done than if he had not set them. The college professor finds the task his most effective instrument in getting work out of his students, and, when we in our personal work have something strenuous or disagreeable to accomplish, it is not infrequently that we utilize the same idea to help ourselves, and it does it.

The inducement to perform the task is always some benefit or reward. It may not always be so immediate as the lump of sugar the child gets, but the work is still done for some reward, immediate or prospective. Further, it is a

well-acknowledged fact that to work at a task, which we recognize as being within our power to accomplish, without overexerting ourselves, is less tiring and far more pleasant than to work along at the same rate with no special goal ahead.

*It is simply the difference between working with an object, and without one.* The hunter who enjoys following the trail of the moose, day after day, through snow and bitter cold weather, would find the same traveling very disagreeable except for the task he has set himself. To the uninitiated, golf seems a very inane sort of game, but its devotees work at it with tremendous energy just for the satisfaction of reducing their score a few strokes. As they become more proficient, they become more enthusiastic, for, having performed one task, there is always one just a little harder to work at. A consideration of this subject will convince us that in the vast majority of people there readily springs up the desire to do something specific if the opportunity offers, and if an adequate reward can be obtained for doing it.

A Natural Method. The idea of setting for each worker *a task with a bonus* for its accomplishment seems, then, to be in accord with human nature, and hence the proper foundation of a system of management. Our problem, then, is to find out how to set a proper task and what the reward should be for its accomplishment.

The ideal industrial community would be one in which every member should have his proper daily task and receive a corresponding reward. Such a community would represent the condition of which Kipling says:

> "We shall work for an age at a sitting
> And never be tired at all."

This is what Scientific Management in its best development aims to accomplish, for it aims to assign to each, from the highest to the lowest, a definite task each day, and to secure to every individual such a reward as will make his task not only acceptable, but agreeable and pleasant. Whatever

we do must be in accord with human nature. We cannot drive people; we must go with the current.

The greatest obstacles to the introduction of this method have not in the past been the workmen, but the foremen and others in authority. Those offering most objection have, as a rule, either not understood what was being done, or have felt their inability to hold their jobs if they were asked to perform them in accordance with the high standards set. Frequently, the higher they are in authority the less they can see that they should have a task set for them. Such a system bears hardest on those who hold their jobs by *pull* or *bluff*, and it is from them that we should expect the greatest opposition. In this we are not disappointed. In fact, there is only one class that opposes us more strongly, and that is the class which is using official position for private gain. Such people will often commit serious crimes in an attempt to prevent the exposure of their irregularities, and no concern should, therefore, undertake the installation of these methods, unless with the avowed purpose of eliminating all kinds of graft and special privileges.

SCHEDULES AS TASKS. The task idea is really so common that we do not recognize it. Every railroad schedule consists of a series of tasks, and in the manufacture of such articles as sewing machines, typewriters and locomotives, the task idea is illustrated by the schedules according to which the various parts are started on their way through the different departments, and day by day make such progress as will bring them to the erecting shop at the proper time to be incorporated into the finished machine without delay.

In the case of locomotives, in particular, the task idea is specifically illustrated by the dates of shipment set, often months ahead, which are lived up to in a very remarkable manner. When the shipping date of a locomotive has been set, there has also been set the time when every piece must start on its course through the shops to arrive at the appointed time in the erecting shop. Inasmuch as this work has been done over and over again, all the principal men in

the works know by heart the schedules of all the parts they are concerned with, and what their tasks are.

Wherever the work is one of general character, this condition exists, for each foreman, and in many cases the various workmen, soon learn the proper routes and time-schedules of the parts they are concerned with.

The grand task of shipping at a predetermined date, then, consists of the sum of those detail tasks, each of which must be performed properly and in the proper sequence, if the shipping date is to be lived up to.

SCHEDULING MISCELLANEOUS WORK. Where the work is miscellaneous in character, however, the task of having each part go through the proper sequence of operations and arrive at the erecting shop in the order wanted, is not so easy. As a matter of fact, it is the feeling of the writer that the inability to get miscellaneous work through a shop on time, and the delays caused thereby, is often the source of as much expense as inefficient work on the part of the operative.

In a small shop one capable man can often so plan miscellaneous work, and keep account of it in his head, that but little expense is incurred from delays or interferences; but in the large shops of today, and especially in plants consisting of several shops, such a thing is quite impossible; and the larger the shop or plant the greater the expense that arises from this source. This, then, is the greatest and most important task to be performed in any works, and it is one for which the management is solely responsible. To go into details of how such a task is performed would be impossible in the short time at my disposal. Suffice it to say, however, that when a start has been made and each foreman receives each day a list of jobs to be done that day, the general efficiency of the works is much increased, though nothing whatever has been done to increase the efficiency of the individual workman. Although such an *order of work* is of great assistance to the foreman, its usefulness increases rapidly as the work is so planned as to avoid interferences and to have all materials and appliances ready for the workman in advance.

With this result the efficiency of the individual increases, and unless his inefficiency is very flagrant, it is far better to solve this general problem first and to take up the efficiency of the workman later, except to the extent of keeping a daily record of his work; for when the large problem is solved, every step made with the individual counts for all it is worth, which is not always the case when work is done in the wrong sequence or by an inferior method.

What I have said has so often proved itself of value, that anybody who gives the subject any thought should recognize the importance of it. I had a case a few years ago where there was a very good foreman of a certain shop, — I say he was good because he intended to do the right thing and he was bright and he knew how to do the work. But he had one failing, a very bad memory. He would promise anything and never perform it. It was not because he did not want to do it, — he would always forget. He honestly forgot. And when we gave him a list of the work in the order in which it was wanted, and presented him each day a list of the work he was to do next, he was perfectly delighted.

I have had similar cases a number of times, and I have always been able in this way to increase the efficiency of the foreman and of the workmen. In one case which I could cite, I went to a large shop where I was told that certain foremen were useless; there was one in particular whom they would have to get rid of. Well, we did not discuss that question. We found that he was always behind in his work, because he was always doing the wrong thing first. We went to work to straighten out what he should do and gave him each day a list of the work he was to do that day. In a short time he caught up with his work, and some months later he came to the superintendent of the shop and said, "There is something wrong in this shop." The superintendent asked, "What is the matter?" "I don't know," said the foreman; "but there is something wrong in this shop." "Well, what is it, if it is wrong?" "Well," the foreman replied, "nobody has been chasing me about my work for three days." That

happened several years ago, and the man is still there as foreman.

Having solved our large problem of scheduling each part through the works, and having devised means for knowing each day whether our schedules are lived up to or not, we come to what most people consider the real problem, that of setting up a task for the workman.

I find many shops have a very nice schedule system; they plan their work beautifully, — at least, it looks very pretty on paper, but they have no means of finding out whether those schedules are lived up to or not. Usually they are not. I have been through shops where the superintendent or manager told me he had a fine system of management, and having described his whole system to me, turned me over to a subordinate to take me around and see how it was working. It has been very seldom when I have found the system working the way the superintendent said it was. He had planned it and had given his orders, but when I got out into the shop and asked questions, I found that the foremen and the people charged with carrying out this system said, "We found we couldn't do it just that way and we have done it this way." One dear old man whom I knew very well was very proud of his shop system. He spent quite a time one day showing it to me, and then turned me over to one of his subordinates to be shown the details of anything I wanted to see. There was absolutely nothing going as he said it was going. The force had not argued with him; they had just gone on and done things in their own way. He had this beautiful system all on paper. It looked to me pretty complicated, but he thought it was fine. Everybody was going on just the same as before, and he was ignorant of the fact. They never brought it up to him; they got things out the best way they could, made whatever excuses were necessary and got through.

With regard to the subject of tasks it may be said that it is only in those cases where the number of routes is small and the sequence of operations fixed, that proper tasks can be set for the workman before the solution of the general

problem. I have been working at one plant for a year and a half where they had a pretty good system of management, and we have not set a task yet. We have been straightening out their routes. We have been fixing it so that the work should go through the shop in the order wanted and not by the snap judgment of some individual. As soon as we have got into the various rooms, — in many cases rooms which were crowded and where work was stacked all round the room — and begun to plan the work so as to have it done in proper sequence and without delay, congestion has disappeared. That has happened in so many cases that it cannot be attributed to accident. In one case which I could cite, the shop was filled with small boxes of little pieces that were in process. There were a great many of those boxes. I said, "The first thing, gentlemen, is to get some racks made and classify these boxes according to the operation which is next to be performed on the pieces." They saw they had a great many boxes there and they built a corresponding number of racks. When they got this work classified and began to lay it out, they found they had many more racks than they needed. The work kept moving instead of standing there.

I find in many factories that the amount of work in process, moving in a desultory way through the factory, is two or three times as great as there is any necessity for, if its course were properly planned. It not only takes up factory space, but it ties up a large amount of capital where work is not properly planned. The ordinary stock-keeper or foreman always wants to give himself about two or three times as much time as is needed to get the work done. He always expects that when a man promises to give him something next Monday, it will be Monday week or Monday two weeks before he will get it. And that is true if the planning of that work is left to a series of foremen. There are many reasons why that has to be so. It is impracticable to do it in any other way. If, however, all that planning is done from one central headquarters, and each man knows how

much he has to accomplish, and it is put up to him in such a way that he can accomplish it, it gets through pretty regularly.

To send a clerk into a shop to time workmen with a stop-watch and set rates, or tasks, naturally arouses the opposition of the workmen; and while I have no doubt that it has been possible in many cases to get more work by so doing, I have no doubt, also, that its effect on the industrial conditions of the country at large has been decidedly detrimental. It creates opposition, and justly.

As I said before, working at tasks is not a hardship, but a pleasure, if they are properly set and adequately rewarded. Before task-setting can be carried on satisfactorily, the workmen must be convinced that we are not approaching them with a scheme for driving, but with one by which they will be benefited. They must be satisfied, too, that the man who is going to study their work knows what he is doing. He should not be a clerk picked up at random and given a stop-watch; he should be a man who knows what the problem is and how to solve it.

Preparation for Task-setting. Among the steps to be taken before setting a task are; to get all machines and appliances in proper order, to establish a proper tool-room where suitable tools can be obtained for work, to arrange to supply the workmen with material in the order wanted, to plan work so that it is very seldom that one job shall be stopped to make way for another. In other words, before we begin the problem of task-setting for the individual, we should arrange conditions so that he can work to the best advantage, with proper ventilation and a comfortable temperature. These conditions alone will materially increase his output, for petty annoyance of any kind reduces his efficiency. If the work requires mechanical skill or ability, the problem should be studied by the most capable mechanic available, and specific instructions set, showing the best way to do the work and the time required to do it. If necessary, and it usually is, the investigator and task-setter should now turn instructor and

show the workmen how to do the work, and the task should be such that a good workman can readily learn to perform it. If the task is set in this manner by a man in whose ability and honesty the workman has confidence, I have but little difficulty getting the task-work started, provided a proper bonus is offered.

This leads to the question, What is a proper bonus? The reply is, that it is such a bonus as will make the workman feel that he is fully compensated for any extra exertion he puts forth.

Judged from this point of view, it is evident that the bonus depends upon the severity of the work. It varies, as a rule, from 20 per cent to 50 per cent of the day-rate. Task-work does not necessarily mean more severe work, but it does mean more continuous work, and work under more favorable conditions, which always produces greater efficiency.

The attempt to set a task so severe that very few people can be taught to perform it, is of no advantage from any standpoint, for few will continue to strive for a reward which they cannot reach. I have seen employers who were much surprised that they did not get an increased output where they had set a reward for it, — surprised that the reward was being earned by one or two only out of fifty or sixty. When a workman has made up his mind that the reward is beyond him, it has no effect.

Performing the Tasks. Having set a task, the responsibility for the performance does not rest upon the workman alone, but must be shared by the instructor, who must see that the conditions under which the task was set are maintained. That is an essential difference between our form of work and the ordinary form of piece-work. The ordinary form of piece-work is to fix a piece-rate, and then let anybody do it, if he can; if he cannot, he gets out. We believe that it is our duty to show the man how to do it, and to do whatever we can to help him perform his task. To complete the scheme, therefore, every case of lost bonus must be investigated and the reason determined. Such investigations, when

the case is that of a man who has learned the work, usually lead to the discovery of slightly defective material, imperfect tools, machine out of order, or any one of a large number of things that might hamper the output considerably, but which would not be noticed unless a special search was made for them. Thus, *the setting of a proper task for a workman also imposes obligations on, or sets tasks for, the management,* with the invariable result of a better and cheaper product.

Task-work in a Machine Shop. The setting of machine-shop tasks is today quite different from what it was ten years ago. At that time machine operations took a relatively long time, and the time between operations was of much less importance. Today, when machine operations are, as a rule, three times as fast, the time of changing jobs has become three times as important, and to plan our work so that there will be no time lost in going from one job to another has become a far greater factor. For each machine-tool operative today, there has to be planned nearly three times as much work as formerly, and necessarily the supervising force must be much greater. It is this increase in machine-tool capacity which has induced me to lay emphasis on the general scheduling of work, so that no more time than necessary shall be taken in changing jobs.

The ratio between the number of men actually engaged on mechanical work and those engaged in supervising or preparing work must necessarily be quite different from what it was before the advent of high-speed steel and methods of instruction and task-setting.

Task-setting in every kind of shop is similar, and although we do not have high-speed steel to reduce time in non-metal-working shops, we have, in many cases, something similar, the benefit of which is never fully realized until a proper and detailed study is made of the possibilities.

I could give numerous illustrations of this. For instance, in the bleaching of cloth there are several processes, one of which is to subject the cloth to the action of an acid. I found a variety of opinion in the plant in which I first worked, as

to how long the cloth should be subjected to this treatment. They told me that they thought an hour was necessary. By watching their performances, I found that, while the man who told me that an hour was necessary usually subjected his cloth to the action of the acid for an hour, he sometimes allowed it to stay in the acid for several hours and sometimes only five minutes. That, of course, opened a field for investigation. He also told me how strong the acid should be, and insisted that he always kept it at that strength. We secured samples of his solution at different times and found that the strength varied from about 1 per cent to 7 per cent. That also opened up a line of study. We found but little difference between cloth which had been acted upon five minutes and that which had been acted upon for an hour. As a result of our studies, we found the strength of acid needed and the time the cloth should remain subjected to it. It had been the practice to pile the cloth in a series of piles, and when it had remained long enough in these piles, to sew the cloth together again and to pull it through the subsequent solutions. This method necessitated the sewing of the top of the second pile to the bottom of the first. As this process was usually repeated several times in the bleaching, it is easily seen that the pieces of cloth naturally became pretty thoroughly "shuffled" by the time the bleaching was completed. If the rope contained several kinds of goods, as was usually the case, the kinds were often so thoroughly mixed that they could not be gathered together again, except with much care and labor. The result was that people frequently did not get all of the goods that they sent to the bleachery, but they got somebody's else, which was sometimes as good, and sometimes not.

The discovery that those goods could be treated in a few minutes enabled us to make a remarkable change in the work and eliminate a great deal of labor, besides keeping all the goods in exactly the order they went in. We devised a machine which automatically turns upward the leading end of a pile of goods formed in it. From this leading end the goods are pulled off at exactly the same speed at which they

are added to the pile. Thus all goods remain in the pile exactly the same length of time and are treated exactly alike, with the result of a uniformity of bleach previously impossible of attainment.

The length of time the goods remain in the pile is governed by the desire of the bleacher and is limited by the size of the machine. Several machines may be placed in series if it is desired to have the time very long.

By means of this machine it has been possible to bleach a number of small lots of different kinds of cloth together, yet to keep each lot intact, and to deliver to the finisher goods so uniform that he can feel sure that like treatment will produce like results. He is thus able to mix his starch according to his formula and be sure of his result.

This one thing has had just as much influence on that industry as improved tool-steel has had on the machine-shop industry. I say it has had, — it will have, when it is extended to the degree to which it will ultimately be extended. The development is proceeding and it is being gradually extended throughout the country.

I give that just as an illustration of what I mean when I say that, in a non-metal-working industry, there is nearly always something in which improvement can be made, just as improvement has been made in the metal-working industry by high-speed tool-steel.

We have found that if work is properly planned, so that unnecessary delays do not occur and the workmen are provided with proper implements to enable them to perform their tasks in the best manner we can devise, they can, as a rule, wherever the amount of work done depends upon physical exertion, do an average of three times as much as they did on day-work, before planning and task-setting were begun, and feel no more tired at night.

Maintaining Proper Conditions. While the setting of tasks under the proper conditions and in the proper spirit, accompanied by a suitable reward for accomplishment, is of great advantage, it is essential that the conditions under which

the tasks have been set should be maintained permanently. Failure to maintain these conditions will work hardship on the workman and will make it impossible many times for him to perform his task. No one should, therefore, undertake the introduction of task-work, unless he is prepared to maintain the conditions of his shop at a high standard; otherwise dissatisfaction is sure to spring up.

The sum of the tasks which can be performed by the individuals of the shop is the shop-task, and the sum of the tasks of the shops the factory-task. Every foreman who can succeed in the accomplishment of his shop-task should be properly rewarded. In such a scheme as this the foreman and the workmen are brought together by mutual interest, and there develops a spirit of coöperation. Under such a scheme as this, it is perfectly evident that there will be a decided increase in profits.

Having satisfied ourselves that these methods, if properly applied, will result in an increased production of wealth, we must, before passing final judgment on the scheme, ask what effect this increase in wealth will have on the industrial conditions of the country.

Effect of Scientific Management on General Prosperity. General prosperity is not promoted by the accumulation of wealth in the hands of one class, but by the interchange, or distribution, of commodities.

Unless, therefore, these methods help the distribution, the community will be but slightly benefited; individual concerns will undoubtedly be largely benefited at first, but it is doubtful if this benefit will continue unless the public at large is also benefited. I emphasize this point, because I have had so many letters from people who looked upon Scientific Management as a new instrument by which they could squeeze a little more out of the workman and give him no more in return. I have no time for those people, and I do not want to have anything to do with them. We must share what we get.

Adam Smith told us, over a century ago, that prosperity

is greatest when the percentage of profits is small, and business, or interchange, large. We also know this to be a fact, and unless some of the economies of these methods are shared with the public in the shape of reduced selling price, thus making possible an increase of business, it is extremely doubtful if these methods will permanently improve our industrial conditions.

The average producer has already done much to reduce costs, especially during the last few years, and the methods outlined promise a reduction that will be still more marked; but until the financier and the selling agencies (by selling agencies, I mean all the middlemen) cease to violate the fundamental law of economics, *that small profits make good business*, the work of the producer in reducing costs will not help business very much.

High cost of living all over the civilized world today is not so much the result of high wages as of high profits. High profits reduce business, and small business, by limiting the demand, enables factories to turn out only a small product, the cost of which is necessarily increased. With regard to that, I might say that a man, for whom I had done some work, came to me during a business depression and said, "I am running my factory only half-full. If I ran it full, I could afford to sell my product at a very much lower price, and still make money." I said, "I am very much pleased to hear that; the cost-system I put in is worth something to you, if it has shown you that." He said, "Yes." I said, "What are you going to do about it?" "Well," he said, "I think I shall run my factory full; I can afford to do it. I am going to reduce my selling price until I can fill my factory." He had got out of the idea of limiting production. There had been a "gentlemen's agreement" among his competitors about price, — they were not going any lower than they had to go; but he found that he could make a great deal more profit by reducing his selling price and filling his factory. Unquestionably, the demand for those goods will increase with the decreased selling price, and his competitors will probably keep

busy, too, if they are willing to come down to the same price. We have in this country all the elements needed to produce the present conditions of small business and high cost of living; and they are all based on the one economic fact which the financier has absolutely ignored, namely, that *large profits always tend to diminish business.*

I believe that this principle should be most carefully considered by students of economics, and that it is of far more importance than details to the public in general.

Scientific Management and Labor-saving Machines. Scientific Management has been likened to labor-saving machinery, and the parallel is very close. In adopting it, however, we should recognize our obligations as well as privileges, and build for the future as well as for the present.

Labor-saving machiney has greatly increased wealth and improved the conditions of civilized man, but with the increase of wealth has come greater relative differences between rich and poor, and it is doubtful if the relations between employer and employee are any better today than they were two centuries ago.

During the time of such an increase of wealth many industrial problems should have been solved, but were not, largely because an economic law was ignored. In the utilization of this new instrument, it will be of great benefit to the community if the laws of distribution are studied along with those of production.

In considering the parallel between Scientific Management and labor-saving machinery, we may note that properly designed and operated labor-saving machinery, when applied to a suitable purpose, has produced great economies, and assisted materially in the production of wealth; but when improperly designed, or improperly operated, has often been a source of great expense. We may expect similar results with what is called Scientific Management.

The high-sounding term Scientific Management should not be allowed to mislead anybody. It is not something that

can be bought wholesale and utilized retail, but simply means: study your problem according to scientific methods, eliminating guess, setting each man a proper task, and allowing suitable rewards for the accomplishment of these tasks. This done, increased efficiency is bound to follow.

In setting a task, emphasis should be put upon the elimination of guess, for there is no surer way to induce dissatisfaction or inefficiency than to change a task or a piece-rate which has been accepted in good faith. On the other hand, when the workmen realize that tasks once set will not be changed, and that they are set in an equitable manner, they not only do not object to the setting of tasks, but they do everything they can to help along the work.

If a proper scheme of management is devised, by which all the available knowledge is used to plan all work, and where tasks are set in accordance with the best knowledge we have, and workmen are liberally compensated for the performance of these tasks, it is without question that marked economies will be effected.

If, on the other hand, the great advantage to be obtained by this new instrument leads employers to adopt ill-designed schemes of management, or to operate even good ones in a poor manner, it is readily conceivable that by so doing they may not be gainers, but serious losers.

As an indication of what may be accomplished by Scientific Management and the Task and Bonus system, I quote from a book called *Making Both Ends Meet*, published by the Macmillan Company. This book was written by Mrs. Sue Ainslie Clark and Miss Edith Wyatt, who are making a study of the work of self-supporting women.

Last winter, when there was so much advertisement given to the subject of Scientific Management, Miss Wyatt wished to make an investigation of the effect of these methods on working women, and visited three plants where the writer had installed, in a measure at least, the principles referred to in this article. Two of these plants were bleacheries and one a cotton mill.

I quote the following concerning the work at the first bleachery — a large concern in New England.

"The first process at which women are employed is that of keeping cloth running evenly through a tentering machine. . . . The tentering machines used to run slowly. This slowness enhanced the natural monotony and wearisomeness of the work. The girls used to receive wages of $6 a week, and to rest three-quarters of an hour in the morning and three-quarters of an hour in the afternoon, with the same period for dinner at noon in the middle of a ten-and-one-half-hour day. After Scientific Management was introduced, the girls sat at the machine only an hour and twenty minutes at a time. Then they had a twenty-minute rest and these intervals of work and rest were continued throughout the day by an arrangement of spelling with 'spare hands.' The machines were run at a more rapid rate than before. The girl's task was set at watching 32,000 yards in a day; and if she achieved the bonus, as she did without any difficulty, she could earn $9 a week. The output of the tentering machines was increased about sixty per cent.

"The girls at the tentering machines praised the bonus system eagerly. They said they could not bear to return to the former method of work; that now the work was easier and more interesting than before, and the payment and the hours were better. One of the 'spare hands' showed me, as a memento of a new era of tenter-hooking machines, the written slip of paper the efficiency engineer had given to her, explaining to her how to arrange the intervals of rest and to start the 'rest' with a different girl on each Saturday — a five-hour day — so that the same girls would not have three intervals of rest every Saturday."

After the present writer left the works, the system was introduced into another part of the factory, but in a modified form. Miss Wyatt's comment on this is as follows:

"But in another part of the factory, the girls at the tentering machines had wished to lump their rest intervals and to take them all together in fifty-minute periods in the middle

of the morning and of the afternoon. Here the 'spare hands' intervals at the machines fell awkwardly, and they were obliged to work for an unduly long time. The girls became exhausted with the monotony in these longer stretches of work; and further wearied themselves by embroidering and sewing on fancy work in the long rest periods. Here the girls were much less contented than in the other department."

"Before the introduction of the bonus system, one girl used to fold, inspect, and ticket. She used also to carry her material from a table near the yarding machine. Boys now bring the material except where at the yarding machines for heavier stuffs it is pushed along the table. The hours, as for almost all of the bonus workers, have been shortened by 45 minutes. The wages which were $7.50 a week are now between $10 and $11 on full time. Almost all the workers here said they greatly preferred the bonus system and would greatly dislike to return to other work."

"In the further processes of folding, some of the work and the lifting to the piles of the sheer, book-folded stuff is light, but requires great deftness; other parts of the work and the lifting to the piles are heavier. The wages before the bonus was introduced was $7.50 a week, and with the bonus rose to $11 a week, in full time. As with the inspectors, the work was now brought to the folders, and the hours were shortened by 45 minutes. Here there was great variation in the account of the system.

"One of the folders on light work, a wonderfully skilful young woman, who folded 155 pieces a day before, and now folded 887, could run far beyond her task without exhaustion and earn as much as $15 a week. She and some of the expert workers paused in the middle of the morning for 10 or 15 minutes' rest and ate some fruit or other light refreshment, and sometimes took another such rest in the afternoon.

"Another strong worker, employed on heavy material, though she liked the bonus system, and said, 'it couldn't be better,' had remained at work at about the same wages as before, because . . . there was hardly more than enough of

her kind of work to occupy her for more than four days a week. She still earned about $8."

"In the last process of stamping tickets and ticketing, the girls work without one superfluous motion, with a deftness very attractive to see; and both here and at book folding justify the claim made by Scientific Management that speed is a function of quality."

With regard to the cotton mill, the following statements may be quoted:

"By and large, the wages of the women workers in the cotton mill had been increased by Scientific Management."

"Concerning the health and conservation of the strength of the women workers in the mill under Scientific Management, the task of the speeders and of the women at cloth inspection tired the girls no more than it had before. In the spool tending and the winding, as the two most exhausting operations in each process, the stooping and the stamping of the pedals, had been increased by the heightened task, the exhaustion of the workers was heightened. But the work of the excitable little spool tender mentioned was finally arranged so as to leave her in better health than in the days when she was employed on piece-work, and the management was now endeavoring to eliminate the stooping at the bobbins. At spinning almost all the spinners found the work easier than before, probably because Scientific Management demands that machine supervision and assistance shall be the best possible. It must be remembered that the adjustment of the conditions in the mill here is comparatively new. Almost all the girls said: 'They don't drive you at the mill. They make it as easy for you as they can.' It was of special value to observe the operation of Scientific Management in an establishment where all the industrial conditions are difficult for women. . . . The best omen for the conservation of the health of the women workers under Scientific Management in the cotton mill was the equity and candor shown by the management in facing situations unfavorable for the women workers' health and their sincere intention of the best practicable readjustments."

In the second bleachery about twelve girls only were working on this system, and they were all employed in folding and wrapping cloth.

"The arrangement of the different processes was so different for each worker, after and before the system was installed, that none of the girls could compare the different amounts of work she completed at the different times. But the whole output, partly through a better routing of the work to the tables, and by paying the boys who brought it a bonus of 5 cents for each worker who made her bonus, was increased from twenty-five to fifty per cent.[1]

"The girls' hours were decreased from $10\frac{1}{4}$ a day, *with frequent overtime up to nine at night*, to $9\frac{1}{4}$ a day with no overtime, the Saturday half-holiday remaining unchanged."

"The whole tendency of Scientific Management towards truth about industry, toward justice, toward a clear personal record of work, established without fear or favor, had inspired something really new and revolutionary in the minds of both the managers and the women workers where the system had been inaugurated. Nearly all of them wished to tell and obtain, as far as they could, the actual truth about the experiment everywhere. Almost no one wished to 'make out a case.' This expressed sense of candor and coöperation on both sides seemed to the present writer more stirring and vital than the gains in wages and hours, far more serious even than the occasional strain on health which the imperfect installation of Scientific Management had sometimes caused."

"No finer dream was ever dreamed than that the industry by which the nation lives should be so managed as to secure for the men and women engaged in it their real prosperity, their best use of their highest powers. By and large, the great task of common daily work our country does today is surely not so managed, either by intent or by result, either for the

[1] It was probably considerably more than that. The methods of doing business before and after the installation of the system were so different that it is almost impossible to get a measure.

workers or for the most 'successful' owners of dividends. How far Scientific Management will go towards realizing its magnificent dream in the future will be determined by the greatness of spirit and the executive genius with which its principles are sustained by all the people interested in its inauguration, the employers, the workers, and the engineers."

THE CHAIRMAN:

IT should be the object of every manager and owner to give the employee a just and reasonable compensation for his labor, and to secure a like return on the capital invested, under all conditions of a fluctuating market. In times of stress of business, when the balance sheet runs badly and a spirit of disquietude pervades the industrial and financial centers, the employer faces his gravest responsibilities as between the care of the employee and the reasonable protection of his balance sheet. But the responsibilities do not rest with the employers only; labor must recognize its share; the opportunities and the responsibilities are mutual. The laborer should recognize that his interests are identical with those of the employer, and should coöperate to secure the most efficient application of energy. In the long run wages depend upon productivity. The detection and elimination of false effort should be the prime object of Scientific Management. Success is not measured by the amount of energy we expend, but by the results produced by that energy. The principle we are considering is that of so applying the efforts of the employee that he shall produce the greatest results with the minimum of exertion.

I am sure we shoud like to hear of the opportunity for efficiency and advancement which this system offers to the employee. We are fortunate to have with us, to present this phase of the subject, a gentleman who was one of the first to become prominent in the field of industrial organization. It pleases me to present Mr. Harrington Emerson, of New York City.

## THE OPPORTUNITY OF LABOR UNDER SCIENTIFIC MANAGEMENT

By HARRINGTON EMERSON
*The Emerson Company, New York*

MR. CHAIRMAN, LADIES AND GENTLEMEN:

IT was my great good fortune to meet Mr. Taylor about ten years ago. We have never worked together. We came into this work along different lines. I have been fortunate in hearing him speak a number of times since, and I have had a number of instructive personal conferences with him. One of the things that most strikes me is how identical our experiences have been, and how, along different paths, we have come to the same conclusions, using sometimes different words to describe the same thing, but oftentimes even into minute methods following the same procedure.

It has been perhaps my good luck or my misfortune, as you may view it, to be obliged to do the big thing quickly rather than slowly. Occasionally that is necessary. A man may take a long time, as long a time as he chooses, to calculate an eclipse, but if he is on a battleship, he has to aim and fire the gun at the enemy with great rapidity. And probably the highest example of Scientific Management and efficiency that the world has ever seen is to be found on an American battleship, when in thirty seconds time they determine the distance of the enemy's ship, and from the floating, heaving support are able to hit the heaving target in the center once in thirty seconds.

For thirty years the railroads have had trouble with their shop employees. There were the Altoona riots of 1877, when the State of Pennsylvania had to pay several million dollars damage to the Pennsylvania Railroad on account of destruction of its property by mob violence. There was the Debs strike in 1894, the Union Pacific strike in 1903, the Atchi-

son strike in 1904, and the Erie strike that lasted from 1904 until 1907. There was a strike of the Great Western, which sent that road into the hands of a receiver in 1907; and at the present time there is a great railroad strike in process on the Harriman lines, a strike involving many thousands of employees and accompanied by violence which in one of the states has necessitated the calling out of the militia; a strike accompanied by damage to property and by murder.

I was with Mr. Burt, President of the Union Pacific, at the time of his strike in 1903. I was called to the Atchison in 1904 at the time of its machinists' strike. The task that the vice-president, Mr. Kendrick, took up with me was this: immediately to continue the repair and renewals of the rolling-stock and the motive power of the road, in spite of the strike; secondly, to take care of a 40 per cent increase in business without securing new shops or new equipment, because the business came suddenly, and it would have taken a long time to build the new shops and to secure the new equipment; thirdly, to restore amicable relations between the employer and the employee, relations that had been disturbed for a long series of years and had finally culminated in this very bitter strike. And, finally, to lessen the unit cost, — although this was incidental, it not making so very much difference to the railroad whether its shop expenses were a little higher or a little lower, so long as it was able to fulfil its duty to the public and take care of the traffic.

The Atchison Road lies in the triangle between the Union Pacific, the Southern Pacific, and the Illinois Central lines, all three Harriman lines now engaged in this strike. For seven years there has been no labor trouble of any kind or description between the Atchison and its shop employees. Its unit costs in one particular department fell to one-third of what they were on the Southern Pacific for the same unit. And last year the employees of the Atchison were paid over $1,000,000 in bonuses above the current rate of wages on the Union Pacific and the Southern Pacific.

The attempt to introduce Scientific Management on the

Atchison was of course elementary, crude and slight; but such as it was, it was at least on a large scale, and for seven years it has withstood the assault of all kinds of critics.

Like Mr. Taylor and Mr. Barth, I have been able to reduce cost-operation to a mathematical formula. All operating costs, all manufacturing costs, consist of simply three elements: materials, labor and fixed charges. If the operation is the making of a pin, you have the elements of material, labor and fixed charges; and if the operations are those of the United Steel Corporation for ten years, you have again materials, labor and fixed charges.

Materials, however, consist of two items, the quantity that you use and the price. Labor consists of two items, the time that it takes and the rate that you pay per hour; and equipment charges, into which fixed charges run, consist also of two items, the time that the equipment operates and its cost per hour to operate. Hitherto we have all paid attention to the price of materials, and we have particularly paid attention to the rate of wages per hour, and we have also paid attention to the cost of our equipment. Those are not the important items. I can safely say they are negligible. *The important items are the quantity of material that is used and the time that it takes to do the work, whether it is the work of man or whether it is the work of equipment.*

To illustrate, in a certain shop it had been costing them $12,000 a year for belting. They bought belting the way shops usually buy belting — the railroad shops at least. The purchasing agent put it up to the belt manufacturers, and the lowest bidder supplied the belting; and naturally it was the very worst belting you could possibly buy anywhere in the market, and it wore out accordingly. I said to the purchasing agent, "Buy the very best belting that you can secure in the whole market." "Why," he said, "it will cost 50 per cent more." I said, "The manufacturer is not getting the price he should get for it. So few people know what good belting is that he has to sell his best belting for less

than its relative value. So, not only pay the highest market price, but give him 5 per cent additional for the privilege of turning back any belt that we do not want after it has been put in operation. That will make him careful to furnish the very best and that will be worth the 5 per cent." Price went up and quantity went down, and in the next year we spent $600 for belting instead of $12,000, and we had the best-belted large shop in the world.

With labor it is the same thing. I recently went through the machine-shop of a big textile mill in New England. I was not particularly interested in textiles, but I was interested in the machine-shop. And when I came back, the president asked me what I thought of it. I somewhat unwisely said, "I don't think very much of your machine-shop." He bridled at that, very much as a woman bridles when you tell her that her baby isn't pretty. And the master mechanic said to me, "Do you understand that this is a shop where we do repair work? We are not a manufacturing shop; we may tie up a mill if we hesitate, if we delay about any work. Have you realized that we cannot apply all these refinements of methods and cards and so on which you put into a shop that is manufacturing?" I might have said that, having been many years in the problem, I had not overlooked it, but the president said, "Let us go out at once, and you tell me what you mean." We went out and the first machine that we came to had a little piece of steel on it about the size of a visiting card. It was a little slotter. It was overrunning the stroke threefold instead of just making a little cut across. The tool was in the metal only one-sixth of the time. The efficiency was only 30 per cent as to time. The speed of stroke was only one-third as fast as it should have been — an efficiency of speed of 33 per cent. They had a diamond-point tool for taking a sixty-fourth of an inch. I think they might have taken with the round-nose tool that Mr. Taylor described last night probably an eighth of an inch; we will allow them a sixteenth. The efficiency of the feed, therefore, was only 25 per cent. He was taking four cuts when a roughing cut

and a smooth cut would have been sufficient. That would have brought him down to 50 per cent on the number of cuts. The end efficiency of that particular operation was only one and a quarter per cent. He was taking eighty times as long to do the work as he should have. I said to the president, "I don't care whether that is a repair operation or not, I don't care whether your mill is tied up; I am somewhat doubtful whether it is necessary to do the work; but assuming that it is, at any rate under Scientific Management you would not overrun your cuts, you would not have these microscopic feeds, you would not be taking four cuts where two are sufficient, and you would save time on your breakdowns."

It takes supervising intelligence to adjust the tool to the hardness of the material, to make a machine get the most out of a tool; and this supervising intelligence is not only worth money but it commands money. Under Scientific Management it commands more money than ever before, because Scientific Management recognizes the intelligence, measures its value in dollars and cents, and realizes that it can be maintained and stimulated only by an efficiency award.

The profit made by a worker is not his cost of pay per hour, but the difference between his expense per hour and his earnings per hour. Under Scientific Management a worker may reduce his expense 20 per cent and increase his earnings 30 per cent, thus increasing his net earnings several hundred per cent.

That is the opportunity of labor under Scientific Management. It is not imaginary, for I have known a great many men who were simply on the ragged edge, men approaching middle age, who increased their net income from $2 and $3 a month, which was all they were able to save, up to $25 and $30 and $40 and even $50 a month, which they invested in houses, in building societies, while one of them set up an automobile repair shop with his savings and of course is on the road to become a millionaire.

The incident of one and a quarter per cent, which I have described, illustrates the *law of dependent sequence.* When you have a number of operations succeeding each other, one coming after the other, each of them may be relatively efficient, but when you multiply the inefficiencies of each with the inefficiencies of all the others, the net result is a tremendous shrinkage in the possible output, as in that actual example which I have given, of an efficiency on the little piece of steel of only one and a quarter per cent. Now this law of dependent sequence was not formerly so much in evidence and operation and so effective as it is today.

The cost formula of efficiency shows that as higher and higher efficiencies are realized, drones, idlers, as well as other wastes are eliminated, and those who actually do the work make all the direct gain. It is the duty and obligation of modern manhood, of the modern corporation, of the modern state, it is the supreme end of Scientific Management, to see that no worker plays unfairly, that all workers have an equal chance.

It furthermore appears that *strenuousness and efficiency are antagonistic and opposite.* The inevitable result of efficiency is to lessen the effort per hour, but to give the worker higher pay for the hour. The greatest opportunity which has ever come to the world's workers is the one now offering, and if they are wise they will seize it and insist on the immediate adoption of efficiency ideals, since the inevitable and unescapable result of efficiency is to increase pay and lessen effort. Scientific Management will bring reward to whoever practises it. Will the wise few practise it and reap reward, or will the many become wise, practise it, and reap reward? Those of us who have been closest to the development of the science hope that it will be used by all, not by the few, and I shall briefly refer to one example of the way Scientific Management works for the benefit of all concerned.

For seven years there had been no shop labor dispute on the Santa Fé. Last year the employees were paid a bonus above current wage rates of over $1,000,000, yet unit

costs were less than on the paralleling roads, because on the Santa Fé the principle prevails that the lower the cost of the road, the higher the pay to the employee, and also the principle that to work under standardized conditions is easier than to work under unstandardized conditions. On the Santa Fé it is conditions that have been standardized, not toil that has been increased; it is wastes and costs that have been decreased in order that pay may be increased.

What is Scientific Management? Why should there be Scientific Management? What is the opportunity of labor under Scientific Management?

Let us first answer the second question. Why should there be Scientific Management? Why is the good old way not still the best?

Up to a hundred years ago human beings used yesterday's sun, last season's sun to do today's work. We were drawing distinctly on the current activities of the sun. Today we have tapped the sun's savings-bank, we are dissipating the energy the sun collected for us millions of years ago through ages and ages. Two centuries ago, yes, as recently as when I was a child, we grew corn and wheat which animals and men ate, and animal muscles and human muscles did the world's work. Today it is coal and oil and gas that run our trains, our plows, our factories, our mills.

When I was born, one-quarter of a ton of coal per inhabitant was the annual production of the United States, about as much horse-power as two able-bodied men could deliver in a year. In 1910 the annual production was twenty-two times as much, or as many horse-power hours as forty-four able-bodied men can deliver.

Last week in Indiana I saw three oil pull-engines hitched to a gang of fifty-one plows turn over eighteen acres in an hour; they could plow up a square mile of land in thirty-six hours with two shifts of eight men. I have seen ground that has never been plowed, always spaded. It would take a man 560 seasons to spade up a square mile of unbroken prairie. I once started out to break a section of level land. I had

a good span of mules and a good breaking plow. I soon discovered that my maximum output was two acres a day and that it would take me four seasons to finish a section. I felt as if I had been condemned to four years at hard labor and I quit. With oil pull-engines and modern gang-plows it would have taken sixteen of us less than a month to plow up sixteen sections, 10,240 acres.

When I was a child we utilized the eighth of an inch of the fall of a river to turn slowly great water-wheels, developing a few horse-power. Today we utilize from crest to foot the falls of Niagara, the drainage of a great lake region. In the words of the philosopher Bowsher of Cleveland, "Formerly we used incarnate energy, today we are utilizing uncarnate energy."

Uncarnate energy hurls our cannon-shot eight miles at an enemy so far away he can scarcely be seen; uncarnate energy drives the "Lusitania" thirty miles an hour across the ocean, drives our trains in eighteen hours from New York to Chicago, lights our cities, moves our trolley-cars, turns our machinery, hustles the automobile along our public roads at forty miles an hour and hurls the aeroplane 12,000 feet high or in straight flight at ninety miles an hour. It is the greatest source of wealth that we have tapped since we learned how to loot the accumulated stores of energy which lie in the earth, — since we have learned also how to utilize the uncarnate sources of energy in man himself.

But we are still living under the laws, under the theories, under the practices and ideals, under the habits of thought of the age of incarnate energy; and those laws, those theories, those practices, those ideals, those habits of thought do not fit present conditions.

We need new ideals, we need new principles; we need new practices, new types of organization, new equipment; we need a new science, we need new types of executives, and these new creations we group under the title of Scientific Management. It is because of the new ideals and the new science that the old way is "no good."

A generation ago, when men first tapped the natural gas, what did they do with it? They let it flow out into the air, a pillar of fire by night, a column of smoke by day. They did not use one one-thousandth part of its energy for any useful purpose whatever. Today we husband it as the most precious of fuels. We have applied science to its use.

The American people whose nation is founded on a Declaration of Independence must put under scientific control and management the tremendous revolution that is going on. If not, it would be better that we had never discovered how to use uncarnate energy. If we are not ready to become men, it were better to remain children. We should be better than pyromaniacs setting fire to the world for the stupid pleasure of watching it burn. We are like a young man formerly in short allowance who has suddenly inherited a great fortune. Shall we wisely use it?

Scientific Management is therefore the discovery and use without waste of the incarnate and uncarnate energy of the universe.

What is the aim of Scientific Management? It is intelligently to use all the available resources and knowledge of the universe in order to realize definite ideals. The ideals are: to use incarnate and uncarnate energy and incarnate intelligence, to decrease toil, to lessen costs that wages and profits may be increased; and so to distribute the loot of uncarnate energy and of the infinite possibilities of incarnate intelligence as to lessen the friction between man and man, thus raising moral, mental and physical standards, but at the same time lessening the destructive strain of living.

Twenty-three hundred years ago Pericles, in his funeral oration for the Athenian soldiers who fell at Marathon, stated the ideals of his age; ideals that in noble height and beautiful expression have never been surpassed; ideals that a few hundred Athenians were able to attain out of a population of many hundred thousand; ideals that in this generation for the first time in history can be made the heritage of all, and will be made the heritage of those who reach up their

heads, their hearts and their hands, and take. Pericles said, "We aim at a life beautiful without extravagance, and contemplative without unmanliness; wealth in our eyes is a thing not for ostentation but for reasonable use, and it is not the acknowledgment of poverty that we think disgraceful, but the want and endeavor to avoid it." The aim of Scientific Management is to realize for every worker Pericles' ideals. It is to give the worker his share in the sack of the sun's savings-bank, to give it to him intelligently, without waste and fairly, and to give it to him as soon as is possible.

The struggle of the age is to induce both employer and worker to use uncarnate energy scientifically. Both can delay the day, neither can prevent its advent.

Wages have increased only where uncarnate energy has displaced incarnate energy, and I defy any employer permanently to depress the wages of men who use uncarnate energy; I defy any union of workers permanently to raise wages for incarnate energy.

Those labor leaders who pretend that unionism is the cause of wage advance deceive their followers, and those labor leaders who denounce the scientific management of uncarnate energy, not only fight against their best friend, but they remind me of the bull, with lowered head, planted on the track, awaiting the onrush of a modern train. A very fine manifestation of pluck, but lamentably poor exhibition of judgment.

The aim of philosophic, scientific action is:

(1) To discover and make available the hitherto unknown resources of the universe. (2) To eliminate wastes from the utilization of both the old and new sources of energy. (3) To distribute equitably the gain. Is there any dissent from these ideals? Efficiency has no use for the man who is anxious neither to discover nor to utilize the resources of the universe. Efficiency has no use for the man who is callous to the waste of those resources. Efficiency has no use for the man, worker or employer, has no use for the corporation or the state, which does not strive to distribute the gain equitably.

In Alaska I once came to a cabin. On the door was a notice:

"You who come are welcome to use but not to abuse what you find. Eat, but do not waste, lest you harm those who come later." This is the law of the world and it is also the law of efficiency.

The laws are fundamental. We are willing to explain them, to reason about them, but we are not willing to admit that they are questionable. If we cannot convert him, we shall eliminate the man who would turn backwards the clock of the universe. If we cannot convert him, we shall eliminate the man who deliberately wastes our heritage and that of our children; if we cannot convert them, we shall eliminate those who stand in the way of equitable distribution of the gain.

The third question is, what is the opportunity of labor under Scientific Management? It is the greatest opportunity that ever came to labor; the opportunity to play the game according to the rule, and to demand individually, collectively and through the state an equitable share of the immense loot to which humanity has suddenly fallen heir.

In so far as labor countenances waste and inefficiency, in so far as it objects to the substitution of uncarnate energy for incarnate energy, in so far as it advocates two hours' time for one hour's work, in so far as it tolerates two men on one man's job, in so far as it refuses to accept the principle of definite time for each operation, in so far as it objects to the fundamental principle of different capacities in different men with corresponding variation in hourly rate, labor is running counter to the fundamentals of Scientific Management and is delaying the greatest opportunity that ever came to it. The question of hours of work per day is a subsidiary question. I have never yet seen an employer object to counting four hours as a full day's work at high pay when the conditions surrounding the work clearly justify this short time. The question of wages per hour is also a subsidiary question. I have seen plant owners cheerfully pay to their workers $12 a day. This was in Alaska; but I spent the evening before I came up here with the owner of a glass plant from

West Virginia, and in looking over his wage sheet we found one man whose daily wages had averaged above $13.10, and another on the same work, whose average was only $3.75; and we both deplored, not that one man was earning $10 more, but that the other was earning $10 less, since the $13.10 man's work was the cheapest in cost in the whole plant. What I deplored with the Alaskan workers was not the $12 a day, but that, when the three months' season was over, these same men, returning to the United States, idled the nine months away rather than work for the local wage of $3 a day. There is a splendid oriental proverb: "It is better to work without pay than to loaf without purpose." The world's greatest workers have always been those who worked whether there was pay in it or not.

Counseling the employee, I regret that able-bodied men in the prime of life deprive themselves and their class of $600 a year more which each might have earned.

The efficiency formula of cost is as inexorable as the formula of centrifugal force. In every object produced there are twenty-eight elements of cost, whether the object be a single pin or the total output for ten years of the United States Steel Corporation. Compensation per hour of workers is one of the twenty-eight items of cost. As the other twenty-seven items are changed to secure lower cost, the twenty-eighth item of wages must increase. It is cost inefficiency that lowers wages, and nothing can raise wages but cost efficiency.

First of all, let it be clearly understood that *strenuousness and efficiency are not only not identical but usually opposites.*

To be strenuous is not the same thing as to be efficient. The man who spends two hours a day as a strap-hanger in the fetid subway, going to and from his work, is living strenuously but not efficiently. The man who tries to read several daily papers and all the monthly magazines is a strenuous but not efficient reader. The American people are the most strenuous people on earth, but also among the least efficient. A man may be very easy-going and with it be either efficient

or inefficient. Scientific Management's aim is to replace the inefficient strenuous life as well as the inefficient lazy life with the efficient life, preferably easy.

Modern life is too strenuous; that is a different question. It was perhaps easier for the carpenter to work twelve hours a day in his own shop, next to his own house, than to work eight hours a day, and spend two hours a day standing in the crowded, often fetid, subway with a long walk at both ends of the route.

The strenuous life has engulfed us all; we live hard whether we are at the top or at the bottom. Peary voluntarily led a strenuous life for twenty-three years, trying to reach the North Pole. He did not have to, he wanted to. What is the gain to any one in a horse trotting a mile in two minutes rather than in two minutes and ten seconds, or what is the gain in the terrific struggle between two baseball teams? If strenuousness is the ideal, then Scientific Management will show how to attain it, but it could equally well show how to attain languorous ease.

An Irishman who was scraping a fiddle was asked whether he was playing the violin by note or by rote. "By nather, it's by main force, be jabbers," and he should have added, by awkwardness.

To stand a lifetime on one leg on top of a pillar is strenuous, but it is not efficient. To see the moons with the naked eye, as some Tatars can, is efficient, but not strenuous. For Prussia to conquer the balance of Germany in three summer weeks was efficient, but not very strenuous; for Germany to overcome Napoleon III in seven summer weeks was efficient, but not strenuous.

Many thinkers, labor leaders, workmen and others have confounded strenuousness with efficiency, and have jumped to the conclusion that piece-work is a sample of efficiency when in reality it is the apotheosis of strenuousness. Efficiency means accomplishing any result with the least time-effort. To creep slowly is neither efficient or strenuous. To creep well is efficient but not strenuous. To creep fast is

strenuous but not efficient. To walk two miles an hour is neither efficient nor strenuous. To walk three and a half miles an hour is efficient but not strenuous. To walk five miles an hour is strenuous but not efficient. To ride a bicycle six miles an hour is neither efficient nor strenuous. To ride a bicycle twelve miles an hour is efficient but not strenuous. To ride a bicycle thirty miles an hour is strenuous but not efficient.

For engineer and fireman to run an oil-burning locomotive sixty miles an hour over a clear and good track is efficient but not strenuous. I was once riding on one of the oil-burning engines of the Santa Fé and we were hurrying along at sixty miles an hour. On one side sat the engineer, on the other the fireman. I was sitting beside the fireman watching him as with his thumb and fore-finger he governed the flow of oil, and he turned to me and said, "This is a cinch." But then he had a second thought coming, and he thought that it was imprudent to talk that way to me, who was advising the road as to economies. He tapped me on the shoulder and above the noise of the locomotive he said, "But think of the added responsibility!" He was right, although he may have put it in the wrong way. I was glad to see him earn higher wages for less effort. To drive a donkey at two miles through desert sand is strenuous but not efficient. To spade up forty acres in 560 man-seasons is strenuous but not efficient. To plow up 640 acres in thirty-six hours with a set of oil pull-and gang plows is efficient but not strenuous.

Let us therefore abolish from our minds the apprehension and antipathy that rightly attach to inefficient strenuousness, and let us welcome efficiency flavored with just as much, and no more, strenuousness as is good for us, with full knowledge that highly strenuous efficiency is not so economical nor so good for us as a moderate scientific efficiency.

Therefore Efficiency and Scientific Management do not include the ideals of terrific stunts, of exhausting endeavor, of stupendous exertion. On the contrary psychologists, physiologists, hygienists, all of whose counsel is necessary for Scien-

tific Management, will tell you that depression in any form is inimical to high attainment, is a form of disease whether it comes from the reaction of alcoholism, of extreme exertion, or from repellent and deadening work.

Mr. Herman Schneider, the educator, divides work into two classes, energizing and lethargizing. There is effort that fills us with joy, other effort that fills us with revulsion. It is the aim of Scientific Management to give every one joyous, not deadening effort.

A friend of mine had gone through a large New England mill to study possibilities of improving efficiency, and as he came out of a certain department, he said to the president: "The men in that department give you more trouble than any other men in the whole mill; and not only that, but in the town they are the most disorderly citizens, causing trouble and fuss. Not only that, but in their home lives they are unsatisfactory; they go away and leave their wives and children." And the president said, "All those things are true, but how did you know it?" He replied, "The lethargizing work that they do makes that kind of men." When a man has been doing lethargizing, deadening, repellent work, where the noise was so great that he could not even hear himself think, and keeping that up for ten hours, after he comes home he has to become some sort of an anarchist to get even. The Germans have a proverb, "All barbers are conservatives and all tailors radicals." And that illustrates a profound psychological truth. The barber, who is busy with his different customers, — in the old time bleeding this one, making a wig for that one, shaving a third, taking out a tooth of a fourth, dressing the hair of a fifth, exchanging the gossip of the day — had plenty of opportunity to work off his surplus energy, his surplus feelings and thoughts. The tailor, sitting with his legs crossed, all day long in the monotony of drawing the needle through the cloth, was engaged in lethargizing employment which deadened him, and when he came out the only way he could get even was to think radically and wish to act radically.

The best illustration that I know of the difference between strenuousness and efficiency is found in the difference between the rooster trying to fly and the eagle. The rooster, if you chase him, squawks and flutters and by great exertion is able to clear an eight-foot fence, and he soon runs into a corner where you catch him with his mouth open, panting. The eagle soars hour after hour and never moves a pinion. The rooster flies strenuously, the eagle flies efficiently, poised as easily as the fireman sat on his oil-burning locomotive. Therefore, one of the fallacies that both managers and men have to dismiss from their minds is that Scientific Management in any way whatever means an increase of strenuousness. It means the reverse; it means less effort and greater result.

Having discovered that strenuousness is not one of the aims or ideals of efficiency, we return to the three aims: (1) The recovery of the hidden resources. (2) The elimination of waste. (3) The equitable distribution of the gain.

It is immensely important not to discourage those who reveal national resources, who eliminate wastes. We cannot very well over-pay them.

It is a tremendously pernicious fallacy that the poverty of the few is due to the wealth of the few. Even if it is true that 2 per cent of the few possess 90 per cent of all the wealth and that 2 per cent of the poor are starving; even if it is true that 1,600,000 people are starving in the United States — and we know that in this land of plenty this is not true — there is not one scintilla of evidence that the poverty is caused by the riches.

In the Seward Peninsula, Alaska, were many Eskimos. They had lived there many thousand years. They barely subsisted, there was no gain in wealth from generation to generation, there was no gain in population, for occasionally in severe seasons whole settlements were wiped out by starvation.

Into this country came a Swedish deserter from a whaling ship. He found indications of gold, he staked some claims.

The rush began. Miners capable of working claims received $10 a day. Gamblers, saloon keepers, lewd women, came in great numbers.

The claim-owners distributed much of the gold from these mines to the workers and to the ditch-builders, and spent the gold for machinery. Some of the claim-workers, after paying the bare cost of living and clothes, squandered their money on the gamblers and women. The right to distinction of one of the original prospectors was not so much that he had found a mine as that he had paid $1,000 for the favor of a woman who thus also gained distinction.

The Eskimos also profited. They found a market for their furs, for their carved ivories, for the fish they caught; many of them worked for wages instead of lolling in the Arctic summer sun.

There were in this elementary community four classes of society: (1) The abnormally intelligent few who had uncovered hidden wealth, gold-bearing rock. (2) The men who worked or contributed to the working of the claims. (3) An abjectly poor class at the bottom, the Eskimos. (4) A predatory class of parasites.

Can it be claimed that the poverty of the Eskimos was due to the wealth of the mine-owners? Can it be claimed that the poverty of the Eskimos was due to the appropriation of natural resources by the mine-owners? Would the class of mine-workers and the Eskimos have been benefited if the mine discoverer had been killed off before he could make known these discoveries? Is the class of wealth discoverers a benefit to humanity or not? Should any but natural laws be invoked to take from the discoverers what they have discovered and distribute it to the workers, the loiterers and the evil-doers?

Men of initiative, the world over, have discovered wealth that had lain dormant for thousands of years. Columbus discovered America, Astor developed the fur trade, James J. Hill built a railroad through a desert, Armour saved what had formerly been wasted in the slaughter of cattle and hogs,

Rockefeller saved what had been wasted in refining crude oil, Harriman added to the value of railroad property by reducing grades, laying a better road-bed, and carrying larger loads more rapidly and cheaply.

Before the days of the Norman conquest there were unusually poor and degraded people in London. Their condition has steadily improved; never through their own efforts, but always through those of the enterprising few who went out to trade abroad, or to build up manufactures at home, or to open up coal and iron mines. In what way is the wealth of the enterprising few responsible for the abject poverty of the few when this poverty has been steadily lessening century after century?

At Nome the wealth of the mine-owner, inside of a few weeks, began to filter down to the Eskimos because there were only four classes. In England it takes longer because there are 400 classes between the top and the bottom, but the process is the same.

There are two theories to wealth distribution: (1) According to a man's deed. (2) According to a man's need.

The first applies to man as distinct from woman, and after man conquered, each man applies the second theory to women and children. To the limit of the man's ability the needs of the women, and through them the needs of the children, are met.

Shall we extend the application of the theory of need also to men in their relations to each other? When the sailor discovered the mine, should a committee of Eskimos have been appointed to take care of it and work it for the common good? As the Eskimos in 500,000 years had not discovered the mine over which they passed daily; as the Eskimos, in fact, placed no value in gold, being perhaps wiser than we in this respect; as they could not have worked it even if they had discovered it; as ultimately they would have to depend on a strong man who knew how, can we escape from the present order?

Which is better? That each one of us, like the birds, hunt

earthworms and flies for himself, as do the robins and swallows; or that the many stand to attention waiting for the lion to make a killing, then pounce on his prey, drive him off and apportion it between them?

Some men become beggars and parasites though born whole, others born blind or without legs become prominent and useful members of society. In all but the fewest cases actual poverty and degradation is due to the fault of the individual, not to the fault of society, not to the fault of other individuals. That philosophy that thinks the boy at the bottom of the line in the spelling-bee is there because the boy at the top missed no words, that the ignorance of the boy at the bottom is the consequence of the scholarship of the boy at the top, is not hurting the boy at the top, who knows better, half so much as it is hurting the boy at the bottom, who, instead of learning his lesson, rails and rants at both teacher and good spellers.

Columbus discovered America, our forefathers started the Revolution, Howe put the eye in the point of the needle, Pullman developed the sleeping car, Peter Cooper made gelatine, James J. Hill without subsidy or land grant built a transcontinental road, John Rockefeller eliminated the wastes in oil transportation, refining and distribution; we should all be poorer, not richer, if their work had been prevented as similar work has been thwarted and prevented in Russia.

Nevertheless, this is begging the question, and I hold no brief to defend the rich and their possessions. I want for them, as for other individuals, the square deal.

The opportunities for the worker are boundless, but what is the worker's share in realizing them, what the duty of the employer, or of the corporation, what the duty of the state?

As to the duties of the state, it should practise Scientific Management, and with its almost unlimited power prevent the greatest evil of all, fluctuating employment brought about by variations in the costs of materials, in interest rates and in mininum wages. The state should afford to every worker

state work at a minimum wage-rate per hour, and it should object to more than a maximum hours of toil per week. The state should furthermore insist on sanitary and safe conditions. The employee is selling his time by the hour, not selling either his soul or his future health.

The corporation should not employ an incompetent or undesirable man. It should employ no man who does not like his work. It should do its uttermost to increase the efficiency of all the other items of cost than wages so that incompetence of management shall not be recouped by wage reduction to those not responsible for inefficiency. The corporation should recognize suitably, and fairly compensate, any individual merit.

The worker should first of all apply Scientific Management to his own life. He should engage only in work in which he is competent, as otherwise he endangers and defrauds fellow-workers, his employer and himself. He should engage only in work in which he can find pleasure, since only pleasurable work can be competently performed. He should apply to himself and to his own life Scientific Management. If he can increase his own earning power 20 per cent by greater individual efficiency, and lessen his living cost 20 per cent by greater home efficiency, he has increased his net earnings many hundred per cent, since net earnings are the margin between receipts and expenses. It is most inefficient to damn fate when the remedy lies in his own hands. Whatever the hours and rate of pay, as to both of which he should have a voice, he should work faithfully, competently and with interest. In fairness to himself, to society, and to the state, the worker should not engage in unlawful occupation.

The number of hours he shall work a week is a matter for consideration and bargaining between himself and his employers. If he work a less number than is reasonable, he naturally lessens by so much his earning power. The rate per hour is one that neither he nor his employer can permanently determine, but he can properly insist on a guaranteed rate per hour as long as he is on the pay-roll.

What can properly be done in an hour is for neither the man nor the employer to determine. It is as technical a problem as calculating an eclipse. The share of the worker in the gain as cost efficiency increases is a proper subject for bargaining. If a fair and reasonable standard time is set, if the worker is paid a bonus for attaining standard time, if he is given full pay for all the time he saves below standard, he can scarcely equitably ask more, nor can the employer equitably give less.

One more word of agreement with Mr. Taylor. In this work of Scientific Management, the great difficulties that we have encountered have come not from the workingmen but from the management; always from the managers, never from the workers; sometimes from the managers of the workers, not from the workers themselves. In one great plant into which I went we proposed to introduce a system of despatching work through the plant. The general manager said, "That might be necessary in some other plant but it is not necessary here. We have that perfected here, as you will see." He pulled down the telephone and said, "Give me Bill. Is that you, Bill? I would like you to move those cylinders that came in yesterday over into the cylinder shop this afternoon about three o'clock." Hanging up the telephone, he said, "Could anything be simpler or more perfect than that?" It seemed to work very nicely. Then we went out to interview Bill. We proposed to him our scheme of despatching. He said, "That thing might work in some other plant, but it would never work here. It is too rotten for any good thing to work in this plant. Let me give you an example. Here you see this track with this boiler on it. I was expecting to unload that boiler today and had got the scaffolding all shored up there so that I could get it off, and I had the gang of men collected, the derricks ready, when I got a call on the telephone. The general manager orders me to move the cylinders over into the cylinder shop. The only way I can move them is on this track. He says he has to have them this afternoon at three o'clock, and I know perfectly he

doesn't need them until next Monday. I was going to do it tomorrow. Now I must move out this car, scatter these men and try to get the cylinders in." And he added, "It is hell." Bill was very willing and ready to welcome a system of despatching that would have helped him avoid that kind of thing, but the manager was not. And that is almost universally the trouble.

# Third Session

FRIDAY AFTERNOON, OCTOBER THE THIRTEENTH

CHAIRMAN, CHARLES H. JONES

*President of The Commonwealth Shoe and Leather Co., Boston*

# SCIENTIFIC MANAGEMENT AND THE MANAGER

## INTRODUCTION BY THE CHAIRMAN

LADIES AND GENTLEMEN:

WE all know that Mr. Taylor's work began about thirty years ago, and that it has been patiently and persistently followed ever since. I believe the principles were reduced to writing some six or seven years ago, but it is within the past year only that the public has had its attention called to Scientific Management. Just now it is very prominently before the public. This very large and interested gathering attests thoroughly the business sagacity of the management of the Tuck School in calling this conference at this time; in fact, incidentally, it shows that they are qualified for the duties of training young men for business.

Why is it that just at this moment Scientific Management seems to be attracting such general attention? It is not accidental; there is a reason.

We all know of the primitive conditions of industry which existed in the early colonial days; there was scarcely a mechanic associated with another; each worked alone. But that society was able to supply its meager wants. Then came what today we call the small factory, established by a man who came up from the ranks, the exceptional man among the workmen in the district in which he lived. That man knew from life-long experience the needs of the people he proposed to supply, and the methods best adapted to supplying those needs. That was the small personally conducted institution which produced all the useful goods of this country for several generations. Our scientific friends tell us that in

some one department of that institution the very highest degree of efficiency was generally attained; that department was probably the department in which the head himself as laborer had been trained. He was able to get very creditable results in the business as a whole without any of the modern theories we are now gathered to discuss.

About fifty years ago the wants of our people became so great that the old way of production could not supply the demand. In every crisis of the world's affairs leaders arise to conduct those affairs to a successful issue. So it was in this matter of production fifty years ago. Almost instantaneously out of the ground grew all these wonderful machines with which we are familiar, and we were enabled to increase our productiveness manyfold.

The population and wealth of the country grew, the wants of the people increased, and enormous aggregations of capital developed manufacturing communities in proportion to the demand. For a time they seemed to have the idea that mere size was sufficient; that results could be accomplished in proportion to the size of these establishments. But, as suggested by the speaker this morning, it was speedily ascertained that such was not the case. What was to be done? There were only two courses open, as I see it. One was to find men of such enormous executive ability that they could develop methods for handling these gigantic institutions; the other was to use the vast resources of the institutions to eliminate competition so that prices could be maintained and profits earned without the best methods in production.

We are all familiar with many corporations which took this latter course, and with some which took the former. The only trouble with the great captains of industry is, that there is not enough of them; there is a limit to the number of men who have the capacity to handle these vast organizations; and so a great number of the organizations direct their energy to the removal of competition, and that, to my mind, is one of the principal causes of the increase of high prices and the increase of high living. Competition is the only force ever

known that compels men to do their business right, and with that support removed, people are forced to pay profits on an extravagant cost. It seems to me that the day for success by these methods is fast drawing to a close. The activities of the government in the enforcement of the Sherman Law have made such methods unpopular at the present time. This is shown by the outcry we hear and read in the financial papers about the enforced stagnation of business. The fact is ignored that the rights of the people have been sacrificed, and that apparently business prosperity cannot be obtained until these evils have been corrected.

It seems to me that right at this point Scientific Management looms very large. It seems to me quite possible that through the development of Scientific Management we shall find the way to increased efficiency.

Through Scientific Management, as explained by various speakers, lies the path for these great corporations to bring themselves up to the possibilities of their existence. There is no excuse for the assembling of their millions of dollars of capital if they can produce nothing for the good of humanity. What they must consider is better service to the community. They undoubtedly have obtained economies in distribution, in the purchase of their supplies, and so on; but in the actual production of commodities I believe those which have really accomplished economies are very few.

The first speaker of the afternoon is a graduate of Amherst, a Massachusetts boy, an enthusiast in the athletics of his institution. I believe he came to Hanover once as captain of the football team, and although he went home with an increased respect for the prowess of the Dartmouth students, he is perfectly willing to come back again, as you see. This gentleman has been interested not only in Scientific Management but in all those forces that make for civic uplift. While he has had his eyes ever on the balance sheet, — the barometer of success in trade, as was stated this morning — I believe from the bottom of my heart that his principal care and the object of his interest in Scientific Management is the promo-

tion of the welfare of those he employs. I believe he has made no claims to being an efficiency engineer. After leaving college he entered an industry which was as much in need of efficiency engineers, probably, as any industry in Massachusetts; the book printing and binding business in a large way. It was not generally considered to be even systematic. And his orderly mind set about arranging, perfecting and improving the details of the management of a vast business which he was called upon to superintend, possibly the greatest publishing and printing business of its kind in the country. After several years' hard work, which resulted in great improvement, he happened to meet Mr. Taylor, and that happened which always has happened when the receptive mind properly trained comes into the presence of new ideas. He absorbed the Taylor theory and rounded out and made complete the principles he had labored to establish. I know you will be glad to hear from Mr. Henry P. Kendall.

## UNSYSTEMATIZED, SYSTEMATIZED, AND SCIENTIFIC MANAGEMENT

BY HENRY P. KENDALL

*Manager of the Plimpton Press, Norwood, Mass.*

Mr. Chairman, Ladies and Gentlemen:

THE plan of this paper is similar to one written previous to the hearings before the Interstate Commerce Commission protesting against the general increase in freight rates. The purpose of that paper was to make clear what was meant by Scientific Management, a term then unfamiliar. To present the same line of thought again receives its justification by the first words in the announcement of this conference, which states: "Notwithstanding the fact that much has been written concerning Scientific Management in newspapers and magazines, there

is no definite conception in the minds of manufacturers and business men of its nature."

That this type is not well known even now is scarcely to be wondered at. Until recently little had been written for the public press and but few manufacturers were working under it, and the small group of men who were associates of Mr. Taylor, or kindred spirits, were too engrossed in their own tasks to do much talking or writing. It is my object, then, to illumine Scientific Management by describing it in terms of business with which we are all familiar, and by comparing some of its essential features with those of more familiar types of management.

Any manufacturing or mercantile business made up of different processes more or less interdependent must, to secure the best results, be so organized that the separate processes and the unit members within these will be brought into systematic connection and operation as efficient parts of the whole. To bring about and maintain this is the function of the management. To do it to the highest known degree is possible only by what we choose to call the science of management.

All types of management seem to fall readily under three heads which, for want of a more explicit terminology, we will call:

I Unsystematized Management
II Systematized Management
III Scientific Management

Of course no classification of this kind is exact. Some departments of an unsystematized plant may equal those in a systematized, and likewise those in the second class may approach the third in efficiency in places; but on the whole this seems a natural division. The functions of the three types of management which will be compared are:

A Accounting
B Purchasing
C Storage of Materials
D Execution of the Work
E Efficiency of the Workers

I. Unsystematized Management. This classification is not made on a basis of the earnings of this group, nor does it mean that they are not meeting their own competition successfully or making money. Such a condition depends on the margin which exists between their costs and selling prices. It does classify them on a basis of efficiency, and means that their costs are not so low as they would be were their form of management the systematized or scientific type. In the opinion of the writer fully 70 per cent in number of the plants in this country would belong in this class, and they are easily recognized. I do not mean that 70 per cent of the workmen in the country are working under unsystematized management, but I think that 70 per cent of the concerns in number would come under this class. We will look at the first function, namely:

A. *Accounting.* The accounting in a business includes not only the ordinary bookkeeping, but the entire clerical system which has to do with orders, records and costs. Accounting is the only means by which the management is informed from time to time of the condition of the business, the progress it is making, its weak and strong points, its selling values and costs, and the efficiency of all its departments. How thorough, lucid and complete the information is as shown by the books indicates to some extent the efficiency of the management and its grasp on the affairs of the company. In the *unsystematized* plant the accounting generally consists of a statement prepared after the annual or semiannual stock-taking, which shows (1) Profit and Loss; (2) Assets and Liabilities. It may possibly show profit and loss by departments or by products, but this last depends on a correct method of ascertaining costs which the *unsystematized* plant seldom has. Such statements are merely a record of an historical fact in most cases. If the statement is bad it is too late to remedy the troubles of the previous year because it shows merely the result of that year. Frequently, due to imperfect methods of stock-taking, appraising and compiling, the yearly statement may be delayed; then the history it tells is ancient.

One example from my own observation — by no means unusual — will illustrate: A large concern ended its fiscal year on January 31 and did not know the result of its year's business until July 17 following, and then in the simple form of profit and loss, assets and liabilities. This information came nearly six months after the close of the business year and was then from six to eighteen months old, too late to do anything to stop the leaks of that year. This was a dangerous case, but a common one.

Any firm of accountants can testify that it is no unusual thing to audit the books of a concern which thinks it is prosperous, and to show that concern that it is insolvent. Within twelve months the writer has had experience with a business in which an audit was made of the books because the proprietor thought his bookkeeper had been dishonest. The audit showed that the bookkeeper had been honest but that the concern was insolvent, and shortly after it paid its creditors thirty cents on the dollar.

A lack of proper cost accounting in the *unsystematized* plant is the cause of losses and of many failures. A notorious example of this appears in the printing industry. In Chicago one large department store makes the boast that it secures its printing below cost. Its method is to send for estimates on printed forms to a large number of printers for every job of printing it has to give out, and then to give it to the lowest bidder on the assumption that some one will have figured below cost. It is reported that at the close of one fiscal year there were no less than fifteen failures of printers in the city of Boston, and it would not be strange if this proportion held throughout the country in this particular industry.

So much importance is placed upon cost of printing at the present time, that one national organization of employing printers has no less than eight men employed installing uniform cost systems in printing offices of its members throughout the country. Too little importance is placed upon accounting in the *unsystematized* plant, and as increasing competition in various industries is continually lowering

the margin of profit, the accounting must become relatively more and more important to this class of business.

B. *Purchasing*. The purchasing of materials, stock and miscellaneous supplies under this type of management may be done by one man or by a purchasing department; but more likely this duty is not very well defined and the purchasing is done by a number of persons, especially those needing the material. Little study is put on the standardization of materials, and different kinds of stock for the same use are often bought. This tends to remnants on some kinds, overstock and understock on others. The buying is seldom done on exact specifications, is not always even by written order, nor is there a predetermined maximum and minimum established of each article that should be carried in stock. The head of the business or the buyer may be an exceedingly shrewd trader and may buy very close at times; but he will not always buy the materials best suited to the work, often overbuys or underbuys for lack of definite information, and is frequently tempted by bargain lots that seem cheap but may cost more to use in the shop.

The lack of well-organized purchasing results in work progressing to a certain extent through the shop until it is stopped and occupies space waiting for some material which has been overlooked, or which is not suited for the purpose. A fairly successful publishing house in one of our large cities does its buying by the *unsystematized* fashion. Last year in making up its statement of profit and loss, the inventory of paper amounted to $20,000. Three-fourths of this paper exists as overruns, or odds and ends of lots which are stored in various printing offices and cannot be used on an average-sized job. They are so scattered they cannot be combined and the make, color, finish and size are different in nearly all the lots. When this house realizes what this stock is, it will be forced to write off nearly $15,000 from its books on what it now considers good assets. Had the buyer in that publishing house standardized his paper so that whatever remained from one lot could readily be used on the next, had

concentrated paper of certain kinds in one printing office, and had accurate records of his available supply, this amount of money represented in stock could be appreciably less and would equal the original cost of the paper. This sort of buying is common among *unsystematized* concerns.

C. *Storage of Materials.* Many manufacturers are willing to devote unlimited space for workrooms, not realizing that the room for the proper storage of materials is just as important and just as profitable as that used for manufacture. In the *unsystematized* plant there may be a general storeroom, but seldom are all the stores to be found in it, and generally they are piled around almost anywhere and in any way that happened to be convenient when received. The order in which such stores are kept usually depends upon the initiative of the men directly in charge, and seldom can one person assume or carry out this responsibility.

The storage of materials and purchasing are very closely related to each other. Loss of time hunting for material is the same whether the material is lost in the storeroom or has not been purchased, and a lack of system in one department will undo attempts at system in the others. The effect of badly organized stores is: (1) Loss of time; work which should go through the manufacturing departments rapidly is held up at different places waiting for materials of the proper kind or amount, and this is a direct loss. (2) Loss of space; more space is required to hold stores in an *unsystematized* way, and for lack of standardization more stores will be kept on hand than are required. Space is also lost in the workroom because work in process does not pass promptly through the workrooms if delayed for material. (3) Loss of capital, because more money is tied up in stores which are not systematized and properly regulated, and more money is tied up in the jobs which represent labor and material sidetracked throughout the plant. A lack of proper records of stores is almost always to be found in the *unsystematized* plant, and the management seldom sees the need for the so-called extra work necessary to conduct that department properly.

D. *Execution of Work*. Orders in the *unsystematized* shop are recorded in a simple manner, sometimes even received and transmitted verbally by the salesman. These are described in part verbally to the superintendent, who may further enlighten the foreman on any of the details of such orders. It is assumed that the superintendent knows his business, that the foremen know theirs, and a workman is expected to sense what is wanted and to ask questions when he is not sure. In this way an attempt is made to fill in the exact and accurate information which the selling end has either not secured or has not transmitted in writing.

The "single foremanship" plan prevails where one foreman handles as many men as he can. The number of men and the amount of work he can look out for is limited by the amount of detail which he can carry in his head and by his physical and nervous endurance. He gives work to each workman when the latter has finished his last job, and depends largely on the worker's knowledge of what to do and how to do it. As questions arise in the progress of the work, or where the written order is incomplete, the workman goes to the foreman who in turn goes to the office for instructions. Meanwhile progress on the work stops.

The workman goes for and selects his tools and appliances, and does his work in the way in which he is accustomed to do that particular kind of work. A difference in method of doing the same kind of work by different workmen and in different shops is often quite marked. A detailed schedule of the average workman's day in the *unsystematized* shop, where such day's work is varied, will show a surprisingly small proportion of effective time.

Piece-work is often used, but is bound to be unequal. The rates, determined by no exact method, are often subject to change, and the output of such piece-work is frequently limited by the unions. This lack of planning the work at the start, of complete instructions, of coördinating the departments and routing work throughout each operation, results in a congestion of unfinished work at many points. This slows

down the output, occupies space and ties up capital. The frequency of mistakes in rush times and of shortages that must afterwards be made up, are not always called to the attention of the management. It is exceedingly difficult, also, in this type of plant to secure a high quality of work and to maintain it uniformly. Then, too, the costs fluctuate a good deal.

E. *Efficiency of Workers.* The efficiency, as a whole, is low and especially so in dull times. It is uneven and varies according to the executive ability of different foremen. The output of a man or machine is largely determined by the opinion of the foreman and not by any exact standard. Piece-work is not always fair, and may be too high or too low. There is no special incentive for a foreman to coöperate with the workman. Therefore, while the majority of the men may be doing what they consider a fair day's work, and some few may be working efficiently, the efficiency of the whole is low.

One example will illustrate a well-known loss in efficiency. A workman in the hat trade performed one process in making a hat by piece-work, and earned not over $15 a week. He was well adapted to that kind of work and could easily have earned $25 a week at that rate and would have been happier doing his best, especially as he needed the money. He was limited to $15 a week by the union. It cost that firm more by this method, because the floor space occupied by this part of the work could have turned out 60 per cent more hats if the men had been rightly selected for that kind of work and had been permitted to do their best. It also cost more because overhead charges were 60 per cent more per hat than was necessary for that operation. More than that, a workman who is well fitted for a task is not happy when he is not doing his best and earning all of which he is capable. There is an economic loss to each, and the result is bad. Even greater inefficiency than this may occur with day workers.

II. Systematized Management. This term as used here applies to the well organized and managed plants which make

no claim to Scientific Management as such. In these plants the managers are methodical and systematic, have studied and systematized each department carefully and aimed to secure the best that has been done in the line of systematizing up to the present time. As stated before, in some departments of many such plants the efficiency is exceedingly good.

A. *Accounting.* In this form of management the accounting is well done. The books will show the condition of the business quarterly or monthly, and in considerable detail. This will include the comparative feature; that is, for example, last year's costs to date with this year's costs for the same period, for a given department or product; will show costs of materials and labor, and the proportion of overhead charges that make up the cost of a single job or a given product. Such results may even be charted and shown in graphic form to the management each month. Other records will come up weekly or even daily. As accounting is the means by which is ascertained the exact condition of the business at a given time, the *systematized* management recognizes the importance of this information. Much of this accounting, however, is done with the ultimate end of securing correct costs, and these cost data are relied upon almost wholly, (1) to establish the selling price, and (2) to point out excessive costs and indicate perhaps where they may be reduced. Many believe that when their accounting is well done they have a systematized and efficient plant, but this really covers one phase only of the management.

Frequently, too, the clerical work in the different departments is not a part of the general accounting, and is not controlled by the ledger accounts. In other words, the same general system of accounting does not permeate the whole plant and help to support itself.

B. *Purchasing.* Materials and supplies are purchased through one man or department, a maximum and minimum generally established, and a decided effort made to purchase the materials best suited to the workrooms. Some analytic methods are used in determining the proper materials, and

standardizing is done on the more important kinds. This purchasing department aims to have a stock of everything required, but buys largely what it is asked to. It does not always make purchases on complete specifications, and a lack of complete standardization increases the detail of that department. So far as the clerical system is developed, however, it is generally quite good.

You will recall the words of a well-known railroad president some time ago who stated, before the Interstate Commerce hearings, that the railroads had reached their ultimate end of efficiency. It is interesting in the light of this statement to note an example of efficiency in purchasing by one system of railroads, which has been acknowledged to me by railroad officials as leading in this particular department. This is the purchasing as done by Mr. Thorne, who buys over $40,000,000 worth of materials annually for the Union Pacific and Southern Pacific railroad systems. One characteristic of Mr. Harriman when he took over a railroad was that he would go to any expense in order to standardize every bit of material used. Mr. Thorne is the man who carried this out. In a letter the other day he told me that in the standardization of printed forms alone he had saved over 30 per cent in the purchase of that particular commodity. In standardizing these forms he reduced them in number, specifying certain standard sizes of paper, type, and other conditions to be followed, and I have no doubt that in his other purchases his methods have secured a great saving over those of competing roads.

C. *Storage of Materials.* A marked contrast to the storage methods of the *unsystematized* plant will be seen at once. Here is an adequate room in charge of a storekeeper who issues stores only on requisitions, and is expected to keep his place neat and orderly and deliver his stores on call. A perpetual list is kept in the office and balanced with the stores, and the balance is proved by an actual count of the stores once a year or oftener. Stores are partially classified and standardized to some extent. It is only the most-used stores that are

assigned to orders before actually called for. The physical handling of the stores, moving them in and out of the storeroom, is done by the assistants of the storekeeper and the efficiency of this work and the orderliness of the department depend wholly upon the kind of man in charge. The central office can exercise very little real control in this department.

Not all *systematized* plants control work from a central planning station by writing the operations for each process before the work is started; therefore materials are not exactly predetermined and work is still likely to be started before it is discovered that some material is lacking. Neither are the quantities always kept up automatically through the purchasing department by a predetermined maximum and minimum of each kind. Also, it is general practice to have storage space for different departments, some of which are not under control of the office; for instance the miscellaneous supplies used for the power department for repairs, piping and plumbing, electrical maintenance, etc., may be scattered about with little idea of order, while the actual materials for use in manufacture may be in good order.

D. *Execution of Work.* A complete set of order-cards for recording and transmitting orders is in use. The worker receives a written order for the work he is to do. This seldom takes the form of an instruction card giving him complete information for every move and every tool. It is apt to say *what* the work is, assuming that he will do it in a satisfactory manner. Workers almost always record their time for each job on a card, which registers the labor cost accurately. They do not always register the time lost in securing tools, materials and further instructions. The planning of a job, except in plants where the work is very largely repetition, is likely to be done as the work proceeds. Piece-work is used wherever possible, and is considered the most economical way of performing a given operation. It is the aim of most *systematized* plants to secure as much piece-work as possible. This may be unfair for different kinds of work to both employees and employer.

Under *systematized* management the system keeps things running smoothly, avoids most of the mistakes due to the lax methods of the first kind of management and turns out a good product. But a lack of centralized planning and centralized control of the workers causes loss of efficiency.

E. *Efficiency of the Worker.* The emphasis of *systematized* management is laid on costs, freedom from errors and bad work, and the greatest output per man and per machine that can be secured. The standard for this output is generally established by the opinions or experience of the bosses, who have neither the time nor the training to ascertain it by exact methods. Great emphasis is put upon the installation of new and modern machinery, but there is not very much analytical work done by the management to ascertain whether the worker is working in the very best possible way, or whether he is adapted to the particular job he is given. The person who has charge of the employment considers that there are four classes of people, — men, women, boys and girls. If the foreman wants a girl, that is sufficient information for the one in charge of the employment, and a girl is hired and assigned. Little or no thought is given to the question whether that particular girl is the right one for the task.

For instance, in bookbinding there are different kinds of work. Laying gold leaf calls for a girl with small fingers and a delicate touch. Strength is not required. Another operation calls for a large, strong girl, who can easily handle bundles of work weighing seven or eight pounds. In proofreading the time reaction of seeing a word and grasping its meaning is a very important feature. Other girls doing inspection must have the ability to concentrate their minds on one particular operation. The different kinds of work demand girls selected with special reference to their aptitude for their particular work. In every factory will be found workers in one department who cannot successfully do their work, but who could successfully do work of another kind. The scientific selection of the worker is almost unknown in the *systematized* plant, and this fact alone makes impossible the highest efficiency.

When I think over the psychology of industrial workers, I am reminded of my own experience in college. In the psychological laboratory tests were made on all my class. I had the quickest time reaction from seeing a flash of light to muscular action in pressing a button; I had the slowest time reaction in the class to seeing a word, comprehending its meaning, and then pressing a button which registered the time it had taken me to see and comprehend its meaning. This experiment showed the reason why I was the slowest reader in my class and why on a given task in reading, in literature or any other subject, I took longer than any one else. While not a sprinter, my record for the fifteen-yard dash has never been beaten, — not because I was a fast runner, but simply because the time reaction to muscular effort enabled me to get off more quickly after the pistol shot than any one else. I never could have made a proof-reader, or earned my salt as a bookkeeper, but I think I should have made a tolerably good motorman.

The step from *unsystematized* management to *systematized* is a difficult one because it generally means a more radical change in the personnel of the supervisory force than does the other step. The *unsystematic* manager is likely to associate with him men of a similar type. To do one's work in a systematic way is not wholly a matter of training, and the foremen and superintendents in a thoroughly *unsystematized* plant cannot always develop the habit of working by means of system. The *unsystematized* plant still remains, either because its competitors are in the same condition or because there is a large difference between costs and selling price, or because the business is dominated by one or more strong characters whose ability in other phases of their work more than makes up for their lack in organizing ability. Sooner or later, however, this class of industries will be forced to change or be eliminated. This has already taken place in a number of industries, as for example, the manufacture of shoes.

Twenty-five or thirty years ago there were more shoe shops than there are today. The competition in manufacturing

shoes and the intricacy of the detail have made it impossible for the *unsystematized* plant to grow beyond the limit of the single foremanship plan, with the result that only the *systematized* plants could increase. The others were absorbed or ceased to be, and today there is probably not an *unsystematized* plant engaged in the manufacture of shoes. Indeed, some few shoe manufacturing concerns are developing *Scientific Management* very rapidly in all their departments. And what has happened to the shoe industry is now happening to other industries which are in the transitional period through which the shoe manufacturing industry passed twenty or twenty-five years ago.

III. Scientific Management. A. *Accounting.* The accounting under *Scientific Management* shows the manufacturing and expense accounts for the year by thirteen periods of four weeks each, instead of twelve monthly periods, and at the expiration of each of these periods it shows the profit and loss and assets and liabilities. These in the *unsystematized* plant are shown yearly, and not always in the *systematized* plant are they shown even monthly. Further, the group and unit costs of the various products, the cost and output of each department and all expenses which might be applied directly to the product, are shown in full, and the "comparative" features are much more useful because four-week periods give a more equal basis for comparison. A monthly statement as shown by the books in the *systematized* accounting does not give an accurate comparison because, for instance, some months will have five pay-rolls where others have four, and the number of working days varies by quite a per cent because there may be five Sundays or five Saturday half-days.

In substance, the general accounts of the company are shown in more complete form every four-week period than is shown by the yearly accounting in the *systematized* class. The ledger accounts have absolute control over the stores department, over the quantity and value of stores, work and materials in process, and manufactured goods; and as every department and function of the manufacturing coördinates with every

other, the accounting becomes a part of the very bone and fiber of the manufacturing.

One radical difference in point of view is that the ascertaining of costs does not have a special system installed for just that purpose, and the ascertaining of costs is not the end sought. Under *Scientific Management* costs come as a by-product of the means used for increasing efficiency. For instance, a ticket made up in the central planning department, when combined with the instruction card, serves to plan the work in advance; then it is used to control the order of work by being placed on a bulletin board; then it gives the workman his particular piece of work to do with the instructions how to do it. On this ticket is stamped the time at which the work is begun and when it ends. This same ticket then serves to check off the progress of the work on the route-sheet. Then it goes to the accounting department from which the man's pay is made up. It is then redistributed and furnishes the labor cost of the particular operation on the cost-sheet of the job. From cost-sheets similar to this are summarized not only the cost on all jobs, but department expenses and charges which appear in each four-week period statement.

In other words, the mechanism used under *systematized* management for ascertaining costs performs little other work; under *Scientific Management* it has performed its part in producing work, and from it, as a by-product, so to speak, come the costs.

The ascertaining of costs by this method is done with but little more expense than is necessary for handling the regular work of operation. Too much emphasis cannot be placed on the value of the comparative feature in accounting. Comparisons are a great spur to increased efficiency, and this fact is recognized as well in the *systematized* management. For example: a certain group of department stores, each doing a business in a different city and non-competitive, have found such good results from uniform accounting methods and the information that comes from comparison, that they jointly

employ an accountant who collects the monthly reports in detail from these stores so as to make a comparison by items, and then prints these data for the use of the management of each store.

For instance, one manager finds that Department A in his store did $50,000 worth of business the preceding month, had $35,000 worth of stock on hand, and is shown in detail what the labor and other expense items of that department were. He sees that another store did $55,000 worth of business in Department A and had a stock of but $20,000. He immediately summons his buyer and informs him of the result of this comparison, and asks why he cannot do as well as the buyer in the other store and release $15,000 of capital now tied up in stock. The knowledge of what can be done and is done by the other store is often sufficient stimulus in itself to cause to be accomplished what otherwise would not be considered possible.

The expense and frequently the shutdowns for the purpose of the annual stock-taking are eliminated under *Scientific Management*, because the accounting absolutely controls the movement of materials in and out of the stores department, so its records show at all times the amount in stores and this value can be ascertained when desired. The work of proving the items of stores is done continuously, and the days, which often become weeks and months, that elapse before even large and well-organized concerns get the results of their stock-taking become a thing of the past. One large concern which is a customer in a business in which I am interested finished its year of stock-taking January 1, and it was early in August of this year before it got the results and knew how much stock it had on hand January 1. The same will apply to the amount of materials and labor in process, which the *systematized* management finds even a harder problem to handle, and also to the value of manufactured goods.

B. *Purchasing*. *Scientific Management* is not satisfied merely to have plenty of materials on hand when wanted, to roughly standardize the principal items of stock used and to

buy at the market rate, but demands that all materials be carefully studied with reference to —

*First.* The greatest adaptability to the work.

*Second.* Quality and uniformity.

*Third.* Price.

*Fourth.* Determination of the proper maximum and minimum that shall be carried, so that the stores department may automatically govern materials and supplies which should always be on hand.

When this has been done, care is taken to make all purchases on detailed specifications. The importance of using materials best suited to the work and which are uniform in quality and by standardization reduced to the smallest variety, is not sufficiently appreciated by the buyer in even the *systematized* plant.

For example, a manufacturer of razors using a thin blade could not secure a steel which would always act alike and produce a uniform result with uniform treatment. He employed a steel expert of reputation to assist him. This expert purchased the best razors that different barbers had, analyzed them chemically and microscopically and, as every man who uses a razor might guess, found very great variation even in the same makes. In fact, he satisfied himself that no razor manufacturer, however well-systematized his plant was, had ever scientifically determined the best steel, or had purchased it on a formula that would standardize this material. As a result, all these years the buying of a razor had been a lottery.

After many tests this expert secured from various steel manufacturers samples of steel on their formulae and his own, and he finally developed a formula that would give the best razor steel known and maintain it uniform. As a result of this method of buying this manufacturer stood alone among the razor producers of the country in ability to produce razor blades of standard quality. If all his methods are as scientific as this, it is doubtful whether his competitors will ever overtake the lead he has secured. This is not an extreme example by any means.

Another illustration of the standardizing of materials. In studying the supplies of a business it was found that there were twelve kinds of wrapping paper regularly used and an investment of $2,500 was needed to carry a sufficient amount. This was standardized and now the twelve kinds of paper have been reduced to four, with a saving of $1,000 in the stock, 60 per cent in the storage space occupied, and the available worth of this paper for the demands that may be made on it is 20 per cent more than what it was formerly. This illustrates the saving made on but one class of material used in a factory where standardization is being worked out.

Such methods of purchasing compel the purchasing department to be intimately associated with the working of the materials through manufacture, and result in the following:

*First.* Uniform material best adapted to the work saves labor and delay in workrooms.

*Second.* Minimum of kinds and sizes necessary to be carried.

*Third.* Storage space saved.

*Fourth.* Lower costs through buying in larger lots.

C. *Storage of Materials.* The physical aspects of a storeroom under *Scientific Management* do not differ greatly from those in the *systematized.* A proper means of holding or piling the stores, laid out in an orderly fashion, is provided. To avoid confusion in a varied terminology, mnemonic symbols are used to designate the different kinds of stores. The maximum and minimum mentioned above are determined for each kind, and kept on the ledger sheets in the central planning room. The bookkeeping for the stores is not carried on in the storeroom, the storeroom force simply acting on orders. The location of the materials is also indicated on the ledger sheets, or, as they are known, the balance of stores sheets.

The storeroom in the *systematized* plant is not likely to carry all the materials and supplies used in the entire plant. The engine-room, plumbing and construction supplies may be carried in places provided for them, but not controlled as other materials are. Stationery and office forms and supplies

may be carried somewhere else under a different system. Even in well-systematized plants such items as are not considered a part of the general stores system cause more or less trouble by being used up unexpectedly.

Under *Scientific Management* it is not sufficient, when materials are required, to send a requisition to the stores department, but all orders or work which require material have the items looked up and assigned to the specific orders by the balance of stores clerks, and this material when assigned to a given order is not available for another order which may follow. This is done before the materials are required for use, and this method serves as advance warning to the stores clerks if an unexpected demand for a particular material is likely to occur. Quick action is then possible in purchasing more.

The work of moving materials into the stores department and moving them from the stores department to the particular place where they are to be used, becomes a function of the planning of the work, and of the routing of the work, and the workman who is to use them should not be delayed or have to give a thought to the materials which he needs for his next job. They are moved in the right condition for his use to the point where he can use them to the best advantage. The *time* which the workman spends looking for or waiting for his materials can be better spent in effective work. The proper working of the stores department in many industries, and especially in mercantile establishments, is a very important one.

D. *Execution of Work.* The theory of the proper execution of work is that it should be planned completely before a single move is made, — that a route-sheet which will show the names and order of all the operations which are to be performed should be made out and that instruction cards should be clearly written for each operation. Requisitions on the stores department showing the kind and quality of the materials and where they should be moved, and lists of proper tools for doing the work in the best way, should be made up for each

operation, and then by time-study the very best method and apparatus for performing each operation is determined in advance, and becomes a part of the instruction.

By this means the order and assignment of all work, or routing as it is called, should be conducted by the central planning or routing department. This brings the control of all operations in the plant, the progress and order of the work, back to the central point. Information which even in the *systematized* plant is supposed to be furnished by the knowledge of the workman or the gang-boss or foreman, is brought back to the planning room and becomes a part of the instruction card.

In many *unsystematized* plants no attempt is made to change the method by which the workman performs his operations. Plenty of time and money may be spent on special machinery, but when that is installed very little time is spent in a close analytical study of the time elements and motions involved in operating, in order to make it possible for the workman to work in the easiest and best way and to furnish a fair basis of remuneration.

When the analytical study has been made, the probable time of operation determined, and a sufficient incentive has been added in the shape of a bonus for performing the work in the given time and in the way specified, then work can be much more accurately controlled from the central planning room because it is likely to be done in approximately the time determined and without lagging.

By *functional foremanship*, which has been described by previous speakers, the management brings to bear on each phase of the work a man particularly fitted by selection, training and experience to assist in performing that part of the work. His function is to assist the worker and coöperate with him to enable him to increase his earning capacity by eliminating trouble or delays or wrong methods. Even in the well-managed *systematized* plant the manager will tell you that the weak point in his business is the inability to secure good foremen, or good superintendents. He demands:

*First.* That a foreman shall know all about the work which is done in his department.

*Second.* That he be a good disciplinarian.

*Third.* That he have the ability to crowd work through and get it out quickly.

*Fourth.* That he be cautious and accurate.

*Fifth.* That he be able to keep account of innumerable details.

To find all these qualities combined successfully in one man is exceedingly difficult, to train such men is also difficult, and to secure them by natural selection and "survival of the fittest" takes too long; but to train men for functional foremanship by selecting the best man fitted to do the particular function and then training him in that, is simply one kind of division of labor which has marked the progress of civilization.

The execution of work which is largely repetition, where the individual processes are simple, reaches a very high efficiency in many *systematized* plants. The difficulties in securing efficiency increase as the work becomes more varied and with less proportion of it repeat-work, and in proportion as these difficulties increase ordinary systems fail to produce results in more intricate work. This can be attained, however, by the central planning room from the analysis and time-study which is put into all operations of work and reduced to instruction cards.

E. *Efficiency of the Worker.* On many simple operations in manufacturing, piece-work has always been considered the most efficient method of securing output and low costs, and it is true that where the remuneration is a just one and when the employee is supplied with proper materials and works to the best advantage, this method of performing work approaches very close to that of *Scientific Management;* but such conditions of piece-work are the ideal rather than the usual. As stated above and emphasized by previous speakers, piece-work with prices based on the snap judgment of a foreman or by an imperfect test of a single worker, is not the correct

method to secure the greatest efficiency. Besides this, there are many kinds of work which are not adapted to piece-work. Under *Scientific Management* the efficiency of the worker and machine depends on five other conditions, after assuming that the parts of the management which have to do with purchasing, storage of materials, etc., are well performed. These conditions are:

*First.* Analysis and synthesis of the elements of operation.

*Second.* Scientific selection of the worker.

*Third.* Training of the worker.

*Fourth.* Proper tools and equipment.

*Fifth.* Proper incentive.

*First.* The first condition on which the efficiency of the worker depends is that *the management shall analyze carefully and thoroughly every operation into its ultimate elements;* shall then reconstruct those elements in their proper sequence, eliminating those which are unnecessary or those which are bad, and reducing the form to a written instruction card for him to follow; the time elements having been determined and becoming a part of the instruction card. It is interesting to see what develops when one really begins to study a seemingly simple operation. The motion-study alone of bricklaying makes possible the elimination of sixteen unnecessary motions. The change in location of a machine which was operated by a girl who sat with her back to an aisle where heavy trucking was done caused an increase of 25 per cent in her work. Every time she heard a truck approaching she involuntarily shuddered, probably wondering if the truck would strike her. Removing this operator to a quiet corner caused the increase.

One factory doing light manufacturing has lately put some time into studying what have always been considered simple operations. In certain places a differently shaped receptacle was made for the articles on which work was being done, bringing the pieces within six inches of the left hand, whereas for years before the worker had had to reach for these and occasionally stop work to bring the articles farthest away

within reach with a sort of hoe. Other operations in this plant have been simplified by changing the position of some workers so that the porter who supplies materials can do so without interrupting and causing a stop in the work several times a day. A study of extra steps and little delays by an intelligent observer is a necessary work before the greatest efficiency can be secured. When all these analyses have been reduced to writing, a study of the type best fitted to do this work is made.

*Second. Scientific Selection of the Worker.* The type of worker who physically and mentally is best fitted to do a kind of work must be selected after a careful analysis of that class of operations made with reference to the physiological and mental differences in human beings. The difference in output and quality of work has been found to vary as much as 40 per cent or 50 per cent in a group of men or women engaged on the same kind of work. As they were of apparently equal intelligence and education, this could be explained only by the physiological and mental differences. As a result of time-study and motion-study of various groups of operations in one large manufacturing plant, it has been found that there are so many workers performing a kind of work to which they are not suited, but who might excel in another kind of work, that the management has laid plans to establish classes to instruct workers to do another kind of work better adapted to their capacities.

Of two different departments, A and B, for instance — A containing thirty girls and B twenty — it has been found that over 20 per cent in A are unfitted for that kind of work, but would be fitted for work in B, and *vice versa.* A scientific selection of the workers is possible only from the analysis of operations. The effectiveness of this will be greater when the principles of the psychology of working and kinds of work are better understood by industrial managers.

The psychology of advertising has lately been coming to the front. The psychology of industrial workers is still a great field for research. The vocational schools will not

perform their true function properly until they come to a better knowledge psychologically of the mental and physical requirements for different kinds of work, and are able by tests to determine in which their pupils are likely to be successes or failures.

Scientific selection of the *workmen* is but a part; the scientific selection of *foremen*, of *superintendents and managers is just as important.* How frequently one sees a man struggling with the details of an office or with the wear and tear of executive work, on the verge of nervous prostration, when that man is wholly unfitted for that kind of work and his attempts successfully to perform it result in his undoing. If managers themselves knew how to judge a man's fitness for his work and were more observing, there would be many less breakdowns and physical wrecks than there are now.

*Third. Training of the Worker.* Having first carried out the study of the operation which has pointed the way to the proper selection of the worker, it becomes the duty to train the worker to do the work in the way which the result of the analysis has shown to be the best way. This will be accomplished by a functional foreman whose duty it is to train the workmen and help them on each job to get started right. If they fail to do the task in the time fixed it is the duty of the functional foreman to find out why they have failed, and to help them do the work as it should have been done. This is a wide departure from the old school, which assumes that the journeyman has sufficient knowledge to do his own work in the most efficient manner. In the training of workmen it is interesting to see how they develop through an aroused interest and coöperation of those over them.

*Fourth. Proper Tools and Equipment.* The fourth condition is that the worker be supplied with the best tools and just the ones needed for the particular operation, and supplied when needed; that he be given the best machine, maintained in first-class condition, so that machine, belt and tool failures will be reduced to the minimum. To maintain the machinery, etc., in this condition is a duty of the manage-

ment, and *Scientific Management* provides the means with which to do this.

*Fifth. Proper Incentive.* Sufficient incentive should be given the worker to perform the operation or the task that has been set in the given time. To make this possible for the worker, functional foremanship is necessary and the principal object of such functional foreman is to assist the worker and eliminate trouble or delay. The functional foreman trained to his specialty will do this more effectively than the old-fashioned all-around foreman. Examples have been given by previous speakers of relative increase in efficiency of the worker as a result of *Scientific Management.* Of course such relative increases in output cannot be considered universal. Certain machines are not mechanically able to run at double or triple their former speeds, but *Scientific Management* tends to lessen the numberless little delays which the condition of the machine, of the material to be worked upon, or the instructions to the worker, may have been responsible for.

It must be to the financial interest of the worker to be industrious, and it has been shown to be for the interest of the management to do everything to make possible and profitable this increased industry of the worker, thereby gaining a more uniform output, and an output per man or machine which is maintained more uniformly in dull or busy times.

There is another feature which is of interest; that is, if the worker engaged on the task and bonus does not receive his materials promptly and on time, if his machine is not in the condition it should be, or there are other avoidable delays, the worker has sufficient interest in the probable loss of his bonus to make a serious kick, and it is the duty of the gang-boss to immediately right this trouble. Therefore, the workman and the boss are together demanding of the management that as nearly as possible perfect working conditions be maintained.

CONCLUSION. The central planning and control of work which is such a vital part in *Scientific Management* is not

developed to the same degree in the *systematized*. In *systematized* plants where complete planning is attempted, however, the instructions and orders particularize *what* is to be done rather than *how* it is to be done.

In the *systematized* plant the system in one department has been planned especially for that department, and is not a part of the system framework which pervades the whole, as in *Scientific Management*, and it is a constant fight to maintain such independent systems and especially to change and modify them with changed conditions or the increased growth of the business.

In closing let us see the effects of this type of management in general on the plant, the product, the worker and the management.

*Plant.* *Scientific Management* furnishes the machinery for maintaining the plant in better condition by centralizing the control, by the use of such devices as the standing order file in which are collected and reduced to writing and properly indexed the practices and rules of the company. From it, by listing and making a certain program of things to be done, — the departments, machinery, shafting, drains, gutters, etc., to be inspected — this program can be handled month after month by routine in a manner which the management has carefully predetermined. To attend to the maintenance of a plant in this way is working to prevent delay and expense rather than cure it afterwards. For instance, eliminating delays due to belt failures, shaft-boxes which have been overlooked and run dry, and indefinite inspection of premises, pipe lines, traps, etc., tends to save expense by preventing trouble.

*Product.* The product of such a plant should be more uniformly even, and there should be fewer mistakes and less inferior work. Once a standard is set for each operation, that standard can be maintained. It costs little more to maintain a high standard under these conditions than a low one under old conditions.

*The Worker.* The condition of a worker's mind has a very

large effect on his physical being. There is a psychological effect on a worker in having the work divided into definite tasks, each one having its goal in sight and sustaining effort to that time. The piece-workers in one plant in which I am interested were interviewed by a woman journalist at the time so much publicity was given to *Scientific Management* by the hearings before the Interstate Commerce Commission, and she asked them how they liked the task and bonus. They said they didn't know why it was, but they liked it; they were earning more. But that was not all: the piece-work flowing to them in an unending stream had been discouraging; there was something they could not understand, but when it was broken up into definite lots they liked it much better. You can discourage any man by setting him to work with a pick and shovel and telling him to shovel away a hill. He knows he can never get it done, but if you say; "Here, you shovel so many tip-carts full in a day, or in a given time, and you will have a certain percentage of increase of pay for that time," you have changed the point of view, and that man every time he finishes a tip-cart full has accomplished a definite task. His effort is sustained for that time, and he is going to be able to sustain that effort in the future. That is one reason why profit-sharing among the working classes is almost an absolute failure so far as increased efficiency is concerned; the time of sustained effort for a year or six months is too long. Neither can a worker do his best work who is nagged by a foreman, who has been given insufficient instructions and is fearful lest he is doing his work wrong, and who, having made a mistake, is jumped on, oftentimes perhaps unjustly. He is not in a frame of mind to do his best work if he wishes to.

In one factory there was great difficulty in keeping the women workers in a certain department. They were either unwilling to continue to work or frequently gave out, and it was a puzzle for some time to find out what the trouble was. When the analysis and time-study were put into this department, it was found that part of the trouble was due to the

fact that they were not earning so much as workers in adjacent departments, that they were nagged by the foreman who did not understand how to handle help, and that they were working at a disadvantage in the arrangement of their work places. The first step was to fit up their places so they could work to the best advantage. A time-study then showed that by working according to instructions they could easily do 50 per cent more work. To insure the work being well done, one of the best girls was selected as an inspector and given charge of their work, the foreman having nothing to do with them. A few of the girls were tried on the extra work, — working under the constant instruction of the time-study man and being paid an additional amount.

All the girls who were physically fitted for this kind of work tried the extra amount, which they did easily. The result of the extra pay, freedom from the nagging of the foreman, and easier working conditions, immediately stopped the difficulty in keeping workers in this department. One or two of these workers, according to the report of the factory nurse, have gained weight since this change was made.

After this had been in effect for a while, the constant request of one girl that she be allowed to undertake one-third more work, or double the original amount, was granted with the approval of the factory nurse, who watched her closely. This was a task not set by time-study, but one which the girl herself thought she could undertake. She found, however, that it was too much and gave it up voluntarily, but she is still doing 50 per cent more work than she was originally. She is a girl well fitted for the kind of work and for her a larger task could be given, but tasks are set with the idea of the average worker who is first selected for the particular kind of work. It must be considered that the effect of task and bonus work under the proper conditions tends to greater industry, better discipline, a happier disposition and greater interest in work on the part of the workers. Greater regularity, greater accuracy and neatness must and do have an influence on health and character.

*Management.* It is probable that the point of view of heads of departments and those responsible for the management becomes quite as much changed as that of the workers. When mistakes are made the responsibility is fixed and the management cannot dodge the fact. A manager also realizes as never before the value that must be placed on analysis. As Mr. Taylor once said: "Thought under *Scientific Management* is 75 per cent analysis and 25 per cent common sense."

When a seemingly difficult operation has been analyzed to its last detail, it is not so difficult to reconstruct it on the proper lines. There is, too, an added interest to the management in the feeling that it is working on a plan, the underlying principles of which are already determined, and the details of which are to be developed in accordance with those principles more and more finely as years go by.

It has been my pleasure to have employed a number of young college men. Before they start to work, while they are in the only impressionable period that exists after they leave college — that is, when they first come under the eye of the manager — I tell them that had I known or realized the comprehensive plan of work under which I am working now, an equivalent of three years of the hardest work I have ever done could have been saved. The hard work would not have been saved, but I should have been saved three years because I should have been working on a plan rather than groping around in the dark and formulating plans many of which have had to be abandoned.

Probably many of you will say, "That sounds all right, but is not fitted for my business." I was very much interested to talk with a man who is the editor of one of the most progressive magazines, who told me today that he had been using some of the apparatus which he had seen in use under *Scientific Management.* His work is editing. Editors have always said that their work is not subject to *Scientific Management* because their work does not deal with systems, — their work deals with brains. I was much pleased to have him tell me that he has constructed a bulletin board in his office

with which he is planning his editorial work, so that already he has done four months work in one month and is up here for a two weeks vacation, or somewhere for a two weeks vacation, because he has that time which he never had had before under the old working conditions. Besides this saving in his own time, he has reduced the amount of money invested in a mass of paid articles, and now buys such only as are required for a given edition.

Beneath all this there is a good deal of philosophy. It seems to me that this is the best solution of a fair compensation for labor because it puts a premium on the efficiency of both employees and employer, and the success of *Scientific Management* depends upon this close coöperation of employer and employee. Along some such line it seems to me will sooner or later be worked out the great problems of labor and capital.

The Chairman: The next speaker is to tell us about the spirit in which an employer should approach Scientific Management. That is one of the most important topics of discussion at this conference. Scientific Management is not to be bought and installed as is a boiler; what is bought depends upon the attitude of the executive force. Mr. Dodge has devoted his life to the invention and perfection of conveying and hoisting machinery, and business men know very well the extraordinary success achieved by his companies in the industrial field. It is the success of Scientific Management. And his business represents success not alone as measured by the balance sheet, but as measured in other important ways. The standards of business are the highest and never vary; there is nowhere a more loyal body of workmen; and there are no secrets about the methods which achieve the success. Over the front of his plant, in letters large enough to be read before one is close enough to read the firm name, is the sign VISITORS ALWAYS WELCOME. Gentlemen, — Mr. James Mapes Dodge.

# THE SPIRIT IN WHICH SCIENTIFIC MANAGEMENT SHOULD BE APPROACHED

By JAMES MAPES DODGE
*Chairman of the Board, The Link-Belt Company, Philadelphia*

Mr. Chairman, Ladies and Gentlemen:

THE old saying that "each one of us endeavors to measure all things in his own pint pot," I am free to admit, applies very well to me, for while the title which has been assigned to me assumes a much broader treatment than a mere recital of personal feelings, the best I can do is to draw freely on personal experiences, disguising them by eliminating the personal pronoun and giving them an air of general application. In this endeavor, therefore, let us talk of the spirit in which we approach Scientific Management.

The term Scientific Management is possibly not the best; many establishments that can lay no claim to any comprehensive scheme of organization contain within them elements of successful management. Mr. Taylor in his treatise on the subject used the title "The Art of Management," while others in speaking of Mr. Taylor's work refer to it as a "Conservation of Human Efforts through the Art of Management." Certainly, where human elements are introduced into a problem, scientific methods alone will hardly achieve a complete solution. It must be a combination of scientific analysis and methods plus consideration for the interest and well-being of the workers, and tact in meeting their inherent resistance to change, or their natural prejudice against something of which they do not understand the full import. Many concerns succeed because they have taken care of this human side of the problem, even though they lack scientific methods of procedure and exactness of information. Other concerns which expect to reduce management to an algebraic formula fail in the attempt because they neglect to foster growth and

initiative in the working force. These concerns have lost sight of the human side of the problem. Truly *Scientific* Management takes account of both sides of the problem, and the method of approach should lie along both of these lines.

The most primitive form of management exists in those establishments in which the owner "carries his office in his hat." When the establishment grows beyond the capacity of the contents of one hat, power and responsibility are delegated to others, until these too become overtaxed. Costs go up, deliveries fall off, and the necessity for a further distribution of authority and responsibility arises. This gradual delegation and subdivision of authority and responsibility is characteristic of what Mr. Taylor terms the "Military System of Management." Under it the shops are run almost entirely by the foremen, and the actual work is performed by men working under constant criticism and goading. The foremen have ideas of management more or less at variance with each other, but the proprietors accept the results as the best that can be obtained, without any proper or regular investigation. The workman who calls at the gate is supposed and expected to be an expert, requiring no instruction or help; the foreman is expected to know how to perform all the duties of his position, and the superintendent is assumed by the owner to know how to manage shop affairs to the practical limit of the possibilities. In such a form of management, criticism from the head goes completely down the line, gathering in vehemence and force as it proceeds, while praise extended from the top usually penetrates only as far as the superintendent's office.

Despotic authority which manifests itself in harsh criticism or tyrannical treatment of the men is undoubtedly the characteristic feature of this form of management. Money returns are the only gage of success, and that foreman is best who can force from his men the greatest amount of work with the least possible compensation. From such methods the men have no redress except to seek employment elsewhere. The general recognition of the fact that the workmen have

rights and that the remark, "You don't have to work here unless you want to" is not a proper answer to a legitimate complaint, is one of the factors which is creating a demand for a general change in methods of management.

It is a serious thing for a worker who has located his home within reasonable proximity to his place of employment and with proper regard for the schooling of his children, to have to seek other employment and readjust his home affairs, with a loss of time and wages. Proper management takes account not only of this fact, but also of the fact that there is a distinct loss to the employer when an old and experienced employee is replaced by a new man who must be educated in the methods of the establishment. An old employee has, in his experience, a potential value that should not be lightly disregarded, and there should be, in case of dismissal, the soundest of reasons, in which personal prejudice or a temporary mental condition of the foreman should play no part.

Constant changing of employees is not wholesome for any establishment, and the sudden discovery by a foreman that a man who has been employed for a year or more is "no good" is often a reflection on the foreman, and more often still, is wholly untrue. All workingmen, unless they develop intemperate or dishonest habits, have value in them, and the conserving and increasing of this value is a duty which should be assumed by their superiors. There is humor and sense in the declaration of the colonel in the *Pirates of Penzance,* "I lead my regiment from behind, I find it less exciting"; for instead of spurring men on by damning them from the front, it is more profitable and more effective in the industrial campaign to extend a helping hand to those in the rear, furnishing them with proper manual and mental equipment to keep up with their fellows.

Under this method the most successful superintendents and foremen are those who can best aid and encourage their subordinates to make the most of themselves and their opportunities, removing obstacles from their paths and enabling them to earn greater rewards without overtaxing

their mental and physical abilities. In other words, Scientific Management consists in the cultivation of the best productive methods. Information can much more economically be ascertained by the leaders, and the knowledge transmitted to the workingmen, than it could be were each man to endeavor to ascertain it for himself.

Probably with all of us it is more difficult to accept a modification of a belief than to absorb a most startling or revolutionary new idea which does not call for any reversal of a notion to which we have tenaciously held. So in this matter of management it was, and is, and always will be essential for us to keep a hopeful equilibrium during transition from our old to our new love; and this transition period is certain to be a trying one.

In the establishments with which I am connected conversion came slowly to nearly all, and some of those who, it would seem, should logically have accepted the innovation with avidity, seemed temperamentally incapable of such acceptance. Those who live entirely in the present, without thought of the future or of the past, can easily acquire the habit of doing things in a new way; but those having active minds are apt to waver between the necessity of advancing a decision and the fear of error born of caution and imagination. Even a measure of intelligence might show that an ardent accepter of Scientific Management and a man unalterably opposed to it in every form, are of the same brain capacity. There is temperamental sectarianism in every profession and walk of life, inexplicable because temperament is inexplicable. We all know men who feel that no one can do things for them as well as they can do them for themselves. It is, of course, possible that there are certain things that the individual can do for himself better than any one else can do them for him; but there are, undoubtedly, thousands of things which can be better done for him by others. Should a man decide that before he looks at an eclipse he must become a thorough astronomer, he will, of course, eventually gain more from looking at the eclipse than those who rush out at first call and are satisfied to wonder

at the phenomenon; but this same temperament might lead a man, if taken sick, to study the medical art until he had become a graduate physician, or to decline to deposit his money in a bank until he had mastered the intricacies of banking, and so on in all the accepted matters of our lives. So it is with some in considering the question of management; instead of investigating in an open-minded way the logic and results, they elect to question every minor step and consider that they must be accorded a complete vindication and proof of the other man's ideas before they are willing to lessen their grip on preconceived and opposing convictions. In other words, we haven't mental legs enough to permit us to maintain a position of straddling both sides of every presented question. It is therefore essential, in order to use the new system of management, that a man have within him a desire to travel in that direction, and that he aid to the best of his ability in the removal of small, real or imaginary obstructions, rather than hold back and allow all his progress to be brought about by the pressure of the breeching, or the pull at the halter. As a matter of fact, it seems that all of us need Scientific Management. If we naturally have it in sufficient quantity we certainly need what we have, but may not need any more. If we have none at all, it would be absolutely ridiculous to say that we could not make good use of some. The degree and quantity are regulated, possibly, not so much by our thoughts as by the invincible logic of progress and existing conditions.

It would of course be ridiculous for an employer of one man to undertake the introduction of Mr. Taylor's "Art of Management," but if he were familiar with some of the underlying principles promulgated by Mr. Taylor, it would undoubtedly be of value to him. The question of exactly how large an establishment should be or how small an establishment may be to introduce Scientific Management in it with profit and success, is of course impossible of numerical answer, because it is dependent upon so many things. It might be likened to what we call civilization. There can be

no dissent to the general statement that civilization is beneficial, but, if by civilization we mean everything in general and in detail that is properly a part of the system of civilization, it would be very difficult for any one to say, provided an uninhabited island were discovered in the Pacific Ocean, that in colonizing it, civilization in its fullest sense could be applied to five, ten, one hundred or some other definite number of people. At the same time, it is quite evident that even one person on this island would be immensely benefited by some elements of modern civilization. In fact, so important would it be to this individual that his very life might depend upon it. On the other hand, if some overwhelming power should decree that he must use every bit of civilization, his speedy demise would be absolutely certain; and so it is in the matter under discussion. Life is too short, individuals and people too circumscribed by their senses and surroundings, to see, feel and believe that they need Scientific Management in its entirety. Nevertheless, no establishment is so small, no business so primitive, but that Scientific Management has details or suggestions that would be helpful. This would indicate that there is no way to define exactly the spirit with which each individual or establishment should approach this subject. It may for all time be governed by temperament, training and the necessities of each individual case. Of course, if an individual has inquired into Scientific Management with a view to adding to his stock of ammunition with which to blow it up, and to pose among his friends as a person of superior intelligence because he says a few bitter or apparently clever things in opposition to the remarkable wave of managerial awakening throughout the civilized world, no good is gained; on the other hand unthinking, untrained acquiescence is probably equally wide of the mark, and only a conscientious investigation of the subject will indicate its value and its best plan of application.

Let us assume that a man having heard of the "Taylor System" is possessed of the idea that he would like to find out something about it. It is more than likely that this

individual has been in the commercial rather than in the practical side of manufacture, and he may be entertained because he has heard rumors that economy is effected and that profits are augmented by the system. Should he send for all the papers that have been published on this subject by the American Society of Mechanical Engineers and read them, however carefully, I fear he would become somewhat confused, inasmuch as a great deal that has been written in these papers, not being directly in line with his personal training and experience, would be obscure and difficult of understanding. He would, however, gather from it that an effort for economical production had certainly been made, and that it is on different lines from those efforts which might be called "of an older school." On the other hand, should the individual be entirely of a mechanical or a manufacturing turn of mind and of only corresponding experiences, his reading of this literature would set in motion an entirely different train of thought. He would find much more in the papers intelligible to him, but as many of the statements would be apparently at variance with his own previous experience, he would be inclined to be very critical of minor details, although in general acquiescent with the main ideas of the papers. In both cases, however, there would be an awakening of interest in the subject which would not be easily put to rest without further knowledge.

Then would come a period of discussion with those having interest in the subject and the clarifying of a great deal which was at first obscure and vague. This result is brought about by a lapse of time, and time is as necessary an element in making a proper impression on the human mind as it is in making a proper actinic impression on a photographic plate. In the latter case we have slow plates and quick plates, and they are acted upon by wide angle, telescopic and numerous other lenses; but human beings have the lenses of their senses sometimes out of focus, which has a potent influence in the registration of impressions upon their minds. After these impressions are registered,

— some slowly, some quickly, some befogged by over-exposure, others deficient on account of under-timing — there comes another necessary and essential lapse of time, and that is in the development of the impressions, either in our brain or on the photographic plates, as the case may be. Now, this development is usually a much greater absorber of time than the mere registering of the impression; and then after the exposure and development comes another period, much longer still, and which may be never-ending, and during which proper use is made of the now developed impressions. Photographic failures are many, but probably not so numerous, proportionately, as mental failures; so we must make ample allowance for variations in the impressions which, apparently, the same exposures may make on different mentalities.

It is almost needless for me to say that the mentality which would receive the initial impressions with proper speed and develop them into their most useful forms is the one that I must talk about, otherwise my task would be endless and your interest entirely used up. We will therefore assume that an individual has received proper impressions, that they have been properly developed, and that it has become his earnest desire properly to introduce Scientific Management into his establishment. The first step, even though he is the sole proprietor and theoretically can do exactly as he pleases, must of necessity be to interest some of his associates. This he will find, as I have previously stated, is not in every case an easy proposition, for the reason that temperamental differences in individuals will require varying degrees and kinds of explanations, and the setting forth of the reasons in different mentally palatable ways. He will of course find, when he approaches his subordinates and they in various degrees accept his views with the feeling that something can be done of advantage to the establishment, that in no case will his leading men consider that anything in this new-fangled management business should be in any way applied to them, though they can see with greater or less degree of certainty

that it would be admirable for everybody else in the place. The problem of overcoming this mental condition is the most difficult of all. The very fact that the leading men of an establishment are beholden to their cleverness and independence of thought for their promotion makes it certain that they will not hesitate to combat the views of their superior, if in their judgment it seems best. In other words, they are not disposed to take orders blindly and do that which they consider ill-advised or unnecessary. Consequently they will ask many questions, and probably it will be necessary and desirable to send some of the leading men out as investigators to go through other establishments and see for themselves what results have been obtained from the innovation. When they return they will not only have seen a good deal that will be entertaining to them, but will be in much better shape to discuss the subject further with their employer.

Then comes the period of incubation of the best plan to pursue in beginning the actual work of the introduction of Scientific Management. If the establishment has good use for all of its leading men and they are properly and rationally busy, it is quite obvious that they cannot devote their time to the acquisition and introduction of all the details of Scientific Management, as well as keep up with their regular lines of work. Therefore it is desirable to call in the services of some one who can bring knowledge and experience to play, to begin the actual introduction. As soon as this is done two forms of activity manifest themselves; one, strange to say, not the easiest to regulate, is the well-meaning, unasked-for assistance to the introduction which usually takes the form of suggestion of improved methods in details that are clearly improvements in the mind of the suggester, but are impossible of acceptance on account of a conflict with other portions of the system to be introduced. This form of activity may be likened to a chorus in which many of the individuals decide that more or less volume of sound, or a change of tone or time, would be better than to follow the dictates of the leader and to sing the music as set before them. The other

development is one either of open or sullen opposition. Frequently proper explanation and patience will overcome this form more easily than the other. The over-zealous cannot be properly curbed without their feeling that they have been "sat upon" or harshly dealt with. I am speaking of these as though they were phases which cropped up and could be disposed of. They can be disposed of in time, but again the time element comes in, and courage, patience and perseverance are required on the part of those at the head of the concern to a much greater extent than would be dreamed of before they had had the experience.

A great deal of care and thought must of course be given to maintain the business of the establishment in all its details while changes are being made, and to avoid having clashes and conflicting methods work hardship to the customers or to the profit-showing of the concern. It is quite obvious that it will be only a short time before two systems are being used in the same establishment, and it will require all the ability available to put up with this state of affairs until the new displaces the old; and probably this is the most trying time for the leading men all through the establishment, because in the stores department, order department, shipping department and, in fact, all the departments, extra work and vigilance are required of every one in order that the confusion may be reduced to its lowest point. In spite of everything, however, there will be days when it will take courage on the part of individuals, and, in fact, courage on the part of the whole management, to keep moving manfully ahead and not to be stampeded by the trying conditions. After a while, however, the benefits of the system will begin to manifest themselves so strongly and the new methods will reveal themselves so satisfactorily, that all will become buoyantly interested and work with redoubled vigor to hasten the entire consummation of the introduction.

So far as the workmen themselves are concerned very little difficulty is experienced. It is essential, however, that the working-man should be told the exact truth, and under no

circumstances should anything be done which has even the appearance of taking advantage of him. He must appreciate that his interests and those of his employer are mutual, and that their happiness and success depend upon mutual trust and consideration. If employers think that by the introduction of Scientific Management they can gain an advantage over the workers, they are making a serious mistake and wasting their efforts in what will eventually turn out to their great and lasting disadvantage. The whole scheme is one of mutual advancement and the corner-stone of the temple of the "Art of Management" is truth; the abutments must be truth, and every stone in the structure must be truth.

Herbert Spencer said that there is a principle which is proof against all argument, and which cannot fail to keep a man in everlasting ignorance; this principle is to condemn before investigating.

# Fourth Session

FRIDAY AFTERNOON, OCTOBER
THE THIRTEENTH

ROUND TABLE DISCUSSIONS

THE APPLICATION OF SCIENTIFIC MANAGEMENT
IN CERTAIN INDUSTRIES

# THE APPLICATION OF SCIENTIFIC MANAGEMENT IN CERTAIN INDUSTRIES

## I. MACHINE MANUFACTURE

LEADER, H. K. HATHAWAY,
*Vice-President, The Tabor Manufacturing Co., Philadelphia*

MR. HATHAWAY: Many phases of Scientific Management apply to the machine-shop, — among them standardization of tools and equipment, standardization of methods, standardization of machinery and machines, the matter of time-study and its application to proper planning, and functional foremanship for increasing the output of machine operators.

One of the first things we find it necessary to do, in applying the principles of Scientific Management to the machine-shop, is to bring about standard conditions which will make it possible for us, through careful planning and administration of the work, to get from each machine the output of which it is capable. That means, briefly, in many cases respeeding the machines. Very few machines are properly speeded to run most efficiently. Mr. Barth has probably done more, and knows more, of that work than most of us. Standardization of the small-tool equipment, so that proper quantities of small tools may always be available, is another step. And following that we have the matter of time-study, setting tasks, and the institution of functional foremanship in place of the old-time foremanship.

I ask Mr. Barth to say a few words on the subject of machine-tools.

Mr. BARTH: The work I have personally been doing in introducing Scientific Management in machine-shops might

be divided into two main parts. First we bring about an orderly procession of everything through the shop, so that every man at his machine or other post gets his work assigned to him by the planning department and not by his shop foreman. That is the preparatory stage, to last, say two years, before we do anything to increase the man's efficiency, or the efficiency of his machine. Next we look into what we can do with the man and the machine. In other words, we first bring the work into the procession we want it done, without asking the question whether it takes five minutes or five hours to do a job, or whether the workman can do it in ten minutes or fifteen. Then comes the great question: "Is each machine fitted for the work assigned to it in the condition it is in?" and it becomes a big and costly job, if we want things done right, to thoroughly investigate all the machinery, and on the strength of this to respeed and probably rebuild a good deal of it; yes, sometimes condemn some of it. Thus, for instance, we always find that lathes of the same size in a machine-shop have great variations in speeds and feeds. Each machine taken by itself is not consistently speeded, and compared with a machine of another maker it shows a considerable difference; while we want to have a certain group of machines alike in every respect so that a piece of work may be routed to any one of these with equal propriety, may be done on one under absolutely the same conditions as on another.

In routing work we sometimes prepare months ahead, and in so doing frequently get a congestion at one or more machines in such a group; for unconsciously the clerks who do the routing get a sort of love for certain machines which they think will do the work in the best way. This necessitates a reassigning of work to other machines, and when these are not just like the machine to which the work was routed in the first place, it means modified instruction cards and new tasks to be set, — the delay, annoyance, and expense of which will far exceed the interest on a good sum of money invested in rebuilding and respeeding machines.

When some fine day in the future the machine-tool builders of this country get together and agree on standard speeds, feeds, T-slots, spindle-sockets, etc., etc., we shall build over old machines that are worth it to conform to these standards, and from then on a good deal of the expense we now incur will be unnecessary.

Mr. Chairman, I suggest that the best way of conducting this meeting would be by the audience asking questions regarding the application of Scientific Management to machine-shops, and I, for one, stand ready to answer any question of that kind.

MR. HATHAWAY: I might say that my object in asking Mr. Barth to speak here is to bring out the importance of standardization in relation to Scientific Management. I think the matter of bolt-slots would be a good thing to begin with.

MR. BARTH: The bolt-slot is one of the devices in machinery for holding the work, and the machine builders have absolutely no consistent rule about it. However, under Scientific Management it becomes necessary to standardize all such slots, and I have spent as high as $1,000 and $2,000 in so making all bolt-slots of nominally the same size, so nearly alike, that the same standard bolt would fit them all. When this is done we can get along with a limited number of these bolts in the tool-room, where they always will be maintained in good condition; whereas, when slots are not standardized, each machine must have a full supply at hand. These will not be properly looked after, and will therefore soon become so bad that greatly increased time will be required in putting them on the work.

MR. SCHUMAKER: I had a question in mind when I came in; it has been in part answered. Though I am very much interested in machine manufacture, my interest is rather incidental, and from the standpoint of the repair-shop. I seem to be connected with the type of management which was described this afternoon as unsystematic. I should very much like to have Scientific Management. What is my first step?

Mr. Hathaway: Your first step is to acquaint yourself as far as possible with what Scientific Management is. I think one of the best ways to do that, after reading such literature as is available on the subject, is to visit plants where Scientific Management has already been installed. I can speak, of course, only for the Tabor Manufacturing Company with which I am connected, and I am glad to take this opportunity to say that we are always pleased to have any one interested in the subject visit us, and to show them everything we can about the matter. I extend to all of you an invitation to visit the Tabor Manufacturing Company. I am sure that Mr. Dodge would be glad to see at the Link-Belt plant any one interested in the subject.

Mr. Lincoln: Approaching the subject from the side Mr. Schumaker has just mentioned, from the repair-shop, I suppose one of the first questions is, what is the expense of shifting over?

Mr. Barth: It is almost impossible to answer that, because it depends on how much there is to be done. Of course the better managed the plant is already, and the better equipped it is, and the better the mental attitude is with reference to this subject, the less it costs. So it is impossible to fix any cost.

Mr. Lincoln: I understand that. I presume any of us who have run shops of any description have all our lives attempted to run certain forms of scientific management; I mean the attempt has always been the production of work at the least possible cost. Now, then, for a person approaching the thing as a new subject the term Scientific Management has something of an academic sound, and I was wondering if there were any fundamental principles, say with reference to clerical work in connection with it, which you would not ordinarily find in the repair-shop.

Mr. Barth: Yes, there is as a rule an increased expense in clerk help, in connection with decreased expense of a different nature.

Mr. Lincoln: Now, the next point; is the decreased expense largely offset by the increased expense?

Mr. Barth: It is a matter, not of added expense, but of changing the elements of the expense, with a total reduction in the cost of doing the work. For example, you do in the planning department a vast amount of work formerly done in the shop. Under the old type of management the workman who runs out of a job frequently finds it necessary to look up his foreman to get his next job assigned to him. Theoretically the foreman may have the next job ready for him, but actually he does not in many cases. After the foreman has been found, he may or may not be able to tell immediately what the man should do next. He may tell him to go to a certain place and get a certain piece of material and put it on his machine. But the man finds that he needs a drawing, and may again have to ask the foreman where to get it. After finally securing and studying the drawing with or without the foreman's help, he finds that he needs certain tools not already in his collection, and to secure these again consumes a great deal of time before he can actually go to work. All of this purely preparatory work should be done by somebody else than the workman himself, who, while this is being done for him, is keeping his machine at work on a job previously prepared in the same manner. Form the habit of looking upon the machine as the real producer which you must keep busy every minute of the day, and the machine tender as a producer only while he is engaged in tending his machine, and therefore as a non-producer while getting ready for a new job, with his machine standing idle waiting for that job. Charging the man's time as productive while he is thus engaged in preparatory work only, is merely a foolish and misleading way of keeping down the ratio of the so-called non-productive pay-roll to the productive pay-roll.

Mr. Lincoln: That is very important it seems to me. I am connected with a machinery business, and I had that notion of the non-producer drilled into me by the older generation, a sort of feeling that every man who was on the place, unless he was actually doing something on the product itself, was a non-producer, and consequently in the way. I

want to hear somebody bring out quite clearly just that point of the non-producer.

Mr. Barth: Nearly everywhere I go, the feeling you speak of exists. Managers try to gage the efficiency of their work by a certain "legitimate" relation between their non-productive and productive expenses, but while such a ratio means a good deal when the line between the two is well defined, it means nothing when you make radical changes in the way of handling matters, the way we do.

In the first place, it is better to use the terms indirect and direct expenses, rather than non-productive and productive, for all necessary expense is productive in some way, or else it would not be incurred at all. You thus class even the most efficient manager as a non-producer, while the large salary he receives proves that he is the most productive man about the establishment. The difference between him and one of your so-called producers is merely that his productiveness cannot be directly recognized in the various work-orders, while that of your producer can. His salary has therefore to reach these in an "indirect" way, in the making up of their total cost, while the wages of your producer reaches them directly.

Mr. Lincoln: What do you include as indirect expense?

Mr. Barth: There is an awful pile of it, I can tell you. Indirect expense embraces almost everything except the cost of the raw materials and the wages of those who work directly upon this.

Mr. Lincoln: Do you lump your helpers?

Mr. Barth: In nine cases out of ten it is best to lump them and charge them indirectly.

Mr. Brooks: Referring to the statement that the mental attitude has a great deal to do with the expense of the introduction of Scientific Management, I should like to learn just what the mental attitude was among the employees in your company when you introduced Scientific Management?

Mr. Hathaway: Our company was at that time badly managed. Our men previous to that time had not been treated any better than they are in the average plant, and

certainly not so well as in many other plants run under the old style of management. There was an attitude of suspicion which resulted in more or less opposition. That opposition and suspicion lasted until such time as their mental attitude was brought around to the point where they could see that through the installation of this type of management, they as well as the management would be benefited. In other words, we had to establish a feeling of confidence between the workmen and the management before we made very rapid progress, but in order to establish that feeling of confidence we also had to make some progress. We gained their confidence partly through explanations and talks and very largely through object-lessons. By object-lessons I mean doing such things as made their work easier, such as having material brought to them, so they did not have to hunt the foreman up when they ran out of a job; and having proper tools brought to them, so a man wasn't compelled to work with tools unsuited to the purpose. In many ways we made their work easier. It all tended to establish a certain amount of confidence in the new scheme, and the further we progressed the less opposition we had.

Mr. Brooks: How many men did you have?

Mr. Hathaway: About 125, possibly 150 men.

Mr. Brooks: How long did it take you to win over the men to a feeling of confidence in the new system?

Mr. Hathaway: I think it was the end of the first year before the men were working for the thing more than against it. Some men saw the advantages more quickly than others. Conditions will be found to be different in almost every establishment, because in some plants the confidence of the workman is already possessed by the management.

Mr. Brooks: Where there is something like 1,000 men, would it take correspondingly longer to win the confidence of the men, or would it come quickly?

Mr. Hathaway: I don't think the number makes much difference. Mr. Barth recently had experience with a plant employing a thousand.

Mr. Barth: If there is decided trouble it is rarely with the individual workmen, but rather with foremen and superintendents, who in having their duties rearranged fear that their services are eventually to be done away with, or who feel that their authority is being reduced by such rearrangements. In the twelve years I have been connected with this work, I have had only a single scrap with a workman. He was a touchy young fellow whom I one day discovered turning up to a finish the two ends of a number of small axles with an enlarged diameter in the middle, without first even roughing off this enlarged middle portion. I suggested to him that this procedure was not a very wise one, and that he ought to rough the middle portion first, so as to have the advantage of the greater stiffness of the rough axle while performing this operation. He at once flared up and told me that he knew what he was about and did not propose to be told by me or anybody else how to do his work. As I had spoken only kindly to him, I was so taken back that I even forgot to show any resentment, and merely told him that he was very unkind in answering me as he did, and that he merely succeeded in making an ass of himself, just the same as I admitted I had often done myself when a young man, and perhaps still did once in a while. This made him cool down some, so that he admitted he had been rather hasty; but when I told him that if he would take up his work again along the lines I had suggested, I would say nothing to his immediate superiors, he said he preferred to quit right then, as he had already made up his mind to quit anyway in a few days. I then left him, hunted up his foreman, and told the latter the whole story, adding that I wanted him to tell the fellow that I was sorry he had behaved so badly, and that if he ever wanted to come back and be decent, he could have his place back; but also that I would see to it that he would not get employment in any of the other departments of the factory, for I correctly suspected that this was what he had in mind. After lying around for a week in an unsuccessful attempt to get into one of the other

departments in which a personal friend of his was foreman, he went to his original home in a neighboring town and secured work, but evidently not to his liking; for about two months later he came back and went to work at his old job.

The difficulty which has appeared lately is not with the individual workmen, but with the unions which believe they are going to suffer and that the new system will throw half of their men out of work. They are afraid that by men becoming too efficient the world's work will be done with half the number of workmen, and that hence the other half will become an enormous array of unemployed. This is rather natural, for with our periodical business depressions and always some men out of work, it is hard to realize that in our industrial age men are never out of work because there is not enough of it to go around, but merely because society is still so poorly organized as a whole, that we do not go about the world's work, which is always on the increase, in a sensible way. I believe that increased efficiency all around will compel a speedier recognition and solution of some of the larger economic questions that confront us. The way we go about the matter, we cannot very well have any trouble with the men themselves, because over a long period we make no changes which effect them in a manner to which they can possibly take any exception; but on the other hand we make it in many ways easier and pleasanter for them to work in the establishment. In this period we also make a number of personal friends among them, who get to know us as men in whom they can fully confide, and as men who they realize are actuated by high motives only, and therefore not likely to do anything against their interests. When you take the next step, therefore, and require a man to do a certain thing in a new way, he will usually take it as a matter of course. Thus we had no trouble at the Watertown Arsenal until the labor unions got together and protested and played on the feelings of the men there, and I do not believe the trouble will last long or amount to much.

Mr. Brooks: How long did it take you to turn over?

MR. BARTH: We worked there for two years before we asked any man to do anything in a different way from what he had done before. We began with the store-room and the tool-room, and analyzed and symbolized the product and the machines, and got a planning room in running order.

You asked about the expenses. At the Watertown Arsenal we spent $33,000 in those two years, of which $11,000 were chargeable directly to the introduction of the system, and $22,000 went into permanent improvements which would not have been made if it had not been for the system.

MR. LINCOLN: How many men did you say?

MR. BARTH: About 500 men.

MR. BROOKS: Is that the concern you have just been speaking about?

MR. BARTH: Yes. But there are various ways of going about this thing. If you haven't the money to spend, simply do a little at the time and pay for it as you go along. But if you have the money, and have faith, spend your money as an investment and take it back in a term of years.

MR. LINCOLN: I anticipate this difficulty, which I should like to get cleared up. The shop I operate I inherited from my grandfather, and a great many traditions have grown up in seventy years. We employ in the neighborhood of 300 men, and I anticipate now that there is going to be more or less difficulty in introducing a serious revolution. How would you go about that?

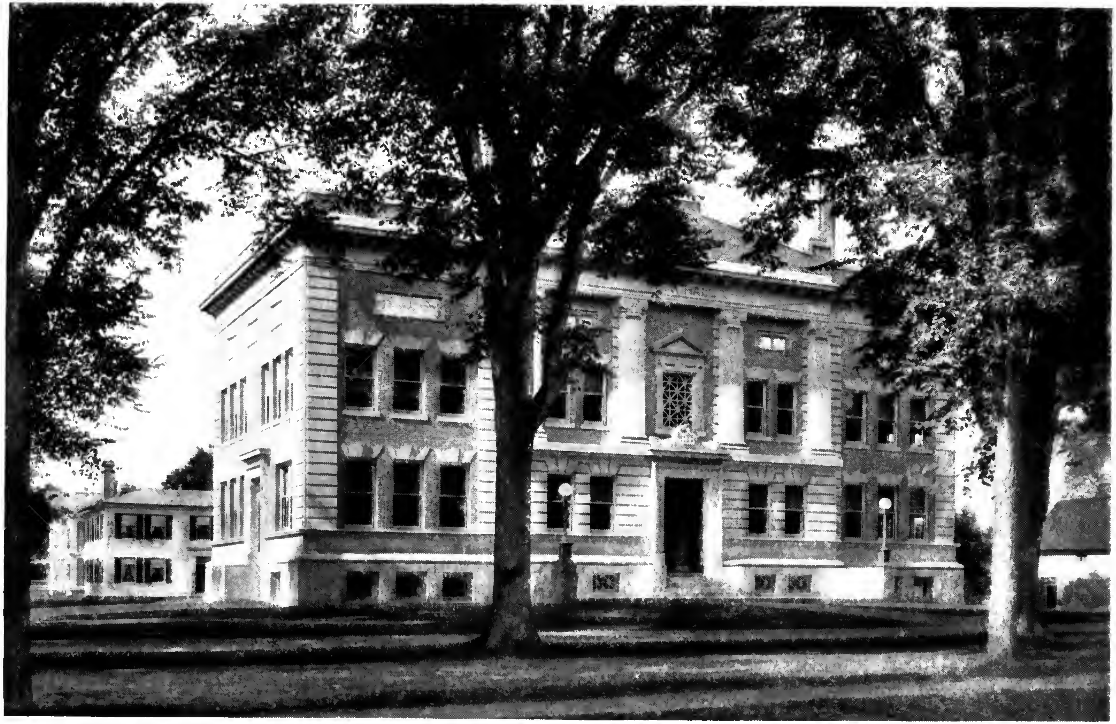
MR. BARTH: What kind of a store-room have you? Can any man go there who needs a piece of machine steel, and pick it out himself?

MR. LINCOLN: Oh, no.

MR. BARTH: If a man cannot do that, then you are already pretty well off.

MR. LINCOLN: No, they have to have a requisition.

MR. BARTH: That is not so bad,— that is the starting point. What about your orders? Do you manufacture a standard product for stock, or only as you get orders, or a little of each?



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MR. LINCOLN: A little of each; we make cotton-mill machinery, but we have a double problem. We are in Fall River and we make looms and power transmission which are standard. Then, on the other hand, being in the center of the cotton-milling district, we have a large repair department.

MR. BARTH: That is, a man comes from the cotton-mill with a fifty-cent job and expects you to go over to the mill and spend $5 worth of time and labor and charge only fifty cents for it?

MR. LINCOLN: There is that double situation there.

MR. BARTH: I have been through a similar factory, but it was worse than yours, because anybody could anywhere pick up the material he wanted. It was the worst-run plant I have ever seen in my life. The management knew nothing about the shop. It was simply a question of operating on a sick patient, — either to kill him quickly, or bring him to; and I am glad to be able to say that the patient is alive today, and when the country's business revives he will soon acquire good health. At any rate he is convalescent, but we came pretty near killing him.

MR. LINCOLN: As far as Mr. Kendall's analysis of this afternoon goes, my shop would be an unsystematic shop. I have had traditions to fight all the time; we have many old employees. One man, for instance, used to come down once in a while so as to round out his fifty years, but that is a rare exception. However, we have men now who have been there twenty and thirty years. I had to fight such men pretty hard to get in any sort of change, but it is now a systematic shop.

MR. BARTH: Have you any lists of materials for the foundry, or does some fellow keep it in his head?

MR. LINCOLN: The order begins with the foundry and goes to the shop.

MR. BARTH: Is there any schedule, or is delivery made when convenient?

MR. LINCOLN: The time is marked when the work is to be in the shop.

Mr. Barth: You evidently have a pretty good shop compared with some. A very unsystematic shop is hard to deal with. It is easier for us to go to a shop that does things some fixed way, no matter how primitive, than where they have absolutely no fixed way. One of the greatest difficulties of the unsystematized place is that everybody in his own way is helping the firm to run the shop. When you suggest what they should do, they think you are going to run things to the devil. If you have any sort of a channel through which your orders pass, you have a good beginning. I don't believe your situation is very bad. It needs further development only. When the work comes to the shop, who decides what is to be done on each piece, — have you any lists of consecutive operations, like turning, milling, etc.?

Mr. Lincoln: When it gets to the shop it is up to the foreman.

Mr. Barth: Does he have any schedule to work to or does he find that John, say, is out of a job, and then go on a hunt to find him a new one?

Mr. Lincoln: There is a list furnished the man at the mill by the foreman, — a list of the things expected from the foundry.

Mr. Barth: Has anybody ever looked over the machinery to see whether your operations are performed in a reasonable time?

Mr. Lincoln: No; that is just the thing I got out of this conference this afternoon.

Mr. Barth: The proper analysis of the machine equipment and its respeeding to make full use of modern high-speed tools, and finally, the education of the men to appreciate their possibilities, is a big job even now, though not so big as it was when the high-speed steel first got on the market; and I shall tell you of a case in which I showed a first-class lathe hand how to run a high-speed tool forty-eight times faster than I found him doing, though the shop had had high-speed tools for two years previous to my coming there. However, I don't believe I shall ever again come across a case so glaringly bad as that.

This man's machine had already been respeeded and "put on a slide-rule," though so far we had not gotten around to make any use of it, and did not expect to for a considerable time to come; and I merely happened, in passing by the machine, to notice that the tool was producing only a very small chip at a very low speed, and doing it in such a way as to indicate that the material was a very soft grade of steel only.

After a little preliminary skirmishing with the operator, I produced the slide-rule for his lathe; and, making a conservative guess at the hardness of the material, I set the rule for such material, for the diameter of work, and such depth of cut as I found the tool was running. The dictates of the rule were a spindle speed six times faster than was being used, and a feed eight times coarser, making a total of forty-eight times the rate of cutting.

In asserting that this speed and this feed would be all right, the operator thought I had gone clean crazy, and when the tool under these ran the full length of the cut under a beautiful blue chip of a kind he had never seen before, and of the possibility of which he had never dreamt, he did not know what to make of it. However, I soon satisfied him by telling him about the discovery and development of the high-speed steel, and that the principal reason why I was around there was my special knowledge of what could be done with this steel. Also, to make him feel perfectly happy about it, we at once got after his job and set a task with bonus for it, which resulted in his making $1 extra per day for weeks at a stretch, and in a reduction of the flat labor cost to the company from a $1.50 per piece of his work, to half a dollar.

Is your line shafting running as it did, say fifteen years ago?

Mr. Lincoln: No, we use high-speed steel.

Mr. Barth: You seem to be in pretty good shape, in spite of your three generations of traditions.

Mr. Schumaker: May I ask, Mr. Chairman, what the plan of procedure would be in such a plant with the traditions

of three generations, where anybody could get material — a plant without a fence around it?

Mr. Barth: You must simply tell them to stop it, and make them understand if they don't get over it they cannot stay with you. We allow old orders to go on in that way, but when new orders come in, the new material is put in boxes and tagged and there is no excuse. When anything comes along tagged, it means the workmen must keep their hands off until they receive a definite order to use it. It requires a great deal of patience to overcome habit.

Mr. Schumaker: Mr. Barth, the pith of what I have heard seems to be that we start Scientific Management with a planning department. I want to know how we arrive at the planning department? Where do we begin?

Mr. Barth: The best way to understand it is to visit one of our shops. In the first place we have to get the space, a fairly large space, for we frequently have as many men collected in the planning department as the establishment has in the shops. We partition off some corner of the shop for the purpose, or else build an annex, and gather into that room gradually all the clerical and engineering force necessary for the planning, so that in the shop itself we have only those employees concerned with the mechanical processes. We have also certain foremen who are middlemen between the planning department and the men who run the machines. The planning work is done as much as possible in the one room. Sometimes in a large plant we have to have several rooms, but we always refer to *the* Planning Department even if we have it divided and in three or four places. Take, for instance, the store-room. The desirable thing is to have the stores in one big room. But I know plants in which they have several store-rooms, but always with one store-keeper in charge of all.

Mr. Schumaker: How do you arrive at the personnel of the planning department? Suppose we want to get Scientific Management in our plant and do not want any external help. How shall we go about it?

Mr. Barth: To do it entirely yourself will be a little difficult. My plan would be to utilize your own men and not hire outside men. For planning machine-work get your best machinists from the shop and put them in the planning room. In the last big planning department I built up there isn't a single man in it who didn't come out of the shop.

That has many advantages. The men always look upon it as a promotion, and you can avail yourself of the knowledge they have. You have in them a product which has been developed during many years. When you have that condition it is very easy to make a planning department.

Mr. Schumaker: Suppose you have an unsystematized shop serving as a maintenance department for an unsystematized mill. Would you start in the manner which you have described, or would you start with a reorganization?

Mr. Barth: You can attack that problem in two distinct ways. If the mill is not systematized you might begin with the mill and let the repair-shop go the old way; or you might begin with the machine shop and consider the mill as if it were a thousand miles away. It doesn't make much difference.

Mr. Pearson: In a case of that sort, wouldn't you ultimately arrive at a planning department covering both mill and the shop?

Mr. Barth: Yes, but there is a limit to the size of a planning department. When the plant is very large it will need a central planning department with sub-planning departments. Each particular establishment must have its own treatment. That is where experience comes in, the experience one gets by making failures. There is no such thing as a man going into a new plant and organizing it in a predetermined way; one cannot look into a situation and see so clearly before he starts that he will not make some mistakes.

Mr. Brooks: What is the advantage in putting in a task man?

Mr. Barth: There is always room for study. Only after a thorough study has been made will you come close to the proper task.

Mr. Brooks: Could you have in connection with the task system a man who hires four or five men under him?

Mr. Barth: That is one of the things we do not believe in — the contract system. We do not believe in any middleman between the management and the workers. He is getting something out of the men. We want the men to get it.

Mr. Brooks: Then you favor only individual pieceworkers?

Mr. Barth: The contract system is a weakness of the management. A man for doing something unnecessary gets a share of the product.

Mr. Green: When an efficiency engineer comes to the plant to work a betterment, what is the ideal relation he should bear to the existing organization?

Mr. Barth: I wish I knew. I think I have an excellent relation at the present time in one of the plants I go to. This company was able to take one of its own men who had become thoroughly imbued with their ideas, — he wrote me a letter and said he had struggled all his life to get some work that he could put his heart into; that now he had found it and life was worth living. He is the man whom I instruct; I deal rarely with anybody except him. He is the middleman between the concern and me.

Mr. Lincoln: You are acknowledging the middleman now.

Mr. Barth: As a temporary thing. The systematizer is not a part of the organization. He is to be kicked out just as soon as you can get along without him. If a systematizer is trying to put the plan in by himself, it drops down as soon as he leaves, and he has to come back and put it in again. But a man on the spot furthers it in his absence. I recommend to you not to get anybody who undertakes to put a system in with his own help, or by himself, but get him simply as a man who is to coach one of your own best men. Pick out the best man you have — the fellow who wants to do it — and have him learn to take the place of the systematizer.

Mr. Lincoln: I want to ask in connection with the

planning department what happens to the old system of superintendent and foreman. Do they become members of the planning department?

Mr. Barth: Yes, or become foremen in a new way — functional foremen. That merely means that instead of having *charge of a group of men* in all their relations to the management, they have each *charge of a function* in all of its relations. So we have several groups of workmen, and instead of having a foreman for each, there is one foreman to perform a certain function for all of those groups; just as in school it is supposed to be of more benefit to have specialized teachers, a teacher for this, that or another subject.

Mr. Brooks: Don't these different foremen have more or less friction with one another?

Mr. Barth: Absolutely none in the long run. The change you make is an occasion for temporary friction — while the foremen are learning their respective functions — but that does not last very long. Whenever there is friction we find that it is because some man feels that his dignity has been hurt, feels that his authority has been curtailed by his being limited to perform one function instead of a lot of them. We point out to such a man that his new duties will require all the attention of one man. He soon finds he has enough to do to perform his own function. There is no real ground for friction.

For instance, in the machine-shop the first functional foreman dealing with the men is what we call the gang-boss. He sees to it that the men always get the material they are to work on, and all the means for doing it — tools, drawings, etc. After a workman has been shown how to set the job up on the machine, this foreman's duty ends. Then comes the speed-boss, who has charge of the work when the machine is actually in operation. Next comes the inspector. The only chance for friction is when the gang-boss has not fully verified the tools and the other boss tells him he has not given the right tools.

Mr. Brooks: Where does the adjustment of the friction come in?

MR. BARTH: Through the disciplinarian. In most cases the chief gang-boss or shop foreman, who is the superior of all these men, will settle the little disputes. When the friction is big enough he will take the disputants out and have a hearing before the disciplinarian.

MR. LINCOLN: Will you give us the organization of a planning department? Take a plant employing, say, 300 men, what is the organization of the planning department?

MR. BARTH: There is no such a thing as a made-to-order planning room. So I don't know that I can answer the question, but I have one plant in mind. The manager is in charge of the whole plant, but he controls it through the planning department. The commercial department sends the orders. The plant can either ship the goods directly from stock or manufacture them. When an order comes, if for goods manufactured and in stock, it goes to the superintendent of production. He looks it over and may not be sure there is stock enough. In a little corner of the planning department are the clerks who have the stock-sheets. The production superintendent will send over to find whether we have that machine in stock, and if we have it these stock-sheet clerks on the strength of the order will issue a requisition on the store-room, and the store-room will deliver the machine over to the shipping department. The document will be sent along with the things. If we don't have the machine ordered, and it has to be manufactured, of course the drawings will be made first, and everything of that kind. But suppose it is a machine we have made before and we have the drawings; it is then only a question of manufacturing. On the strength of the shipping order is made out a manufacturing order. The manufacturing order is put on record, and then the next step is to get all the necessary material, send it to the shop, and see that all the necessary operations are performed, that the parts are put together and then run into the shipping department.

Each machine to be manufactured has for it what is called an assembling chart. This is an analysis which shows every

piece — with every operation on it — in the order in which it must come through the shop, that it may be assembled in the simplest manner.

MR. FRY: Isn't all that immensely complicated in a shop where there is a foundry, a wood-working department and a box shop?

MR. BARTH: If you have distinct departments like that, you have sub-planning departments. The physical condition of the shop is frequently such that we cannot make a big central planning department; but the main control comes from it. The foundry, for instance, would be furnished with a list of the pieces wanted; how to get them is decided by the foundry itself and its own planning department.

MR. BATEMAN: Has the problem ever been worked out with sub-planning departments in the shop? You actually have had those conditions?

MR. BARTH: Yes, the minute the shop gets big you have a general planning department and sub-departments in other places, but the sub-departments have to work from schedules prepared by the main planning department, just the same as the planning department must accommodate itself to the customer on the outside.

MR. BATEMAN: The central planning department would simply send the order to the sub-department?

MR. BARTH: Yes, for things going out the next day or next week. Revise the list every day, week or hour, according to the conditions, and if a repair-job comes in, get busy at once.

MR. BROOKS: Do a great many departments in a business tend to complicate the situation so to make this thing impracticable?

MR. BARTH: I have never seen any such plant, but I have reason to believe that the organization of the planning department would take longer.

MR. BATEMAN: If you are buying your castings outside would you make your purchasing department a sub-planning department?

Mr. Barth: That depends; if you buy from a great many foundries, and buy out of town, then you must organize the purchasing department as you would any other department.

Mr. Schumaker: How much is bonus payment a part of Scientific Management?

Mr. Barth: It does not belong necessarily to it. There is not a single detail we practise which is a necessary element of Scientific Management. Scientific Management means certain principles, and the vehicle of those principles can be almost anything. I am constantly modifying the details of the system. The trouble with all systems of paying a man is, you haven't attempted to get at how long it takes to do the job.

Mr. Schumaker: Do I understand that the payment of the bonus is simply to make the path towards Scientific Management easier?

Mr. Barth: No, the payment of a bonus does not come till we set the task. After all, what you pay the workman is the smallest end in most manufacturing costs. The indirect expenses are usually so great, — the depreciation on the plant, taxes, insurance, president's salary, the commercial end, and certain waste — that what the workman gets is the small end of the whole cost.

Mr. Schumaker: Eventually all our activities will be under Scientific Management. Then the 20 per cent bonus will be received by everybody, and cease to be a bonus.

Mr. Barth: What will eventually come of that is hard to say.

Mr. Schumaker: I brought up this question because all I have heard of Scientific Management has been associated with the bonus.

Mr. Barth: Our method is called scientific because it determines exactly — scientifically — the length of time in which a man can do a piece of work, and that permits a wage proportional to the workman's contribution. I do not care so much about the employer — except as an engineer who is

doing a nice piece of work for him — as about giving the employee more money and making his condition more tolerable and himself happier. The most attractive thing is, that men dare to be frank instead of hypocrites and liars, and acknowledge absolutely what can be done; for in spite of the opposition we met with for a while, we have not failed to make everybody our friend.

## II. TEXTILE MANUFACTURE

LEADER, EUGENE SZEPESI

*Szepesi & Farr, Textile Engineers, Boston*

MR. SZEPESI: My duties are simply to lead you in putting questions and clearing up matters regarding Scientific Management in the operation of a textile mill. Every mill man knows very well, even in cotton or wool or worsted, finishing, bleaching or dyeing, that there is a best way to do a thing. Mr. Emerson says there is a best way even to boil an egg, and that is a fact. As you remember, Mr. Taylor mentioned last evening that ordinary shoveling is artistic work, and told how he reduced the load from thirty-eight to twenty-one pounds and increased the efficiency steadily. He found that twenty-one pounds is just the right quantity for a man to shovel.

Now let us see what a man can do, for instance in the cotton-mill. Here is one proposition. Recently I developed Scientific Management—I give it that name, because I cannot find a better one—in a mill. The winding department is run with a certain degree of efficiency; the average is 56 per cent. For the Foster winder, which is well known to us, for a certain number — for instance, number 20 2-ply cotton — the girl is tending twenty-five spindles. I asked, "Why is a girl tending twenty-five spindles on 20 double cotton yarn?" The answer was, "Because we cannot split a machine." I want to tell you what we have done to find out how many

spindles should be tended by a girl on a Foster winder. I knew that 20 double cotton yarn is equal to 8,400 yards single yarn. I knew by experiment that the variation in length is from 3 per cent to 6 per cent. The percentage permitted is 5 per cent which is equal to 420 yards. The result is that I have a yardage of 7,980 yards of cotton on a Foster winder which is run at 130 feet per minute. These are the facts. I have cotton yarn, I have a machine; what is the duty of an operative in tending the Foster winders? I am simply taking the Foster winder as an example, but the same principle applies to everything. First of all, she has to beat out the skein. Looking at the operation, I found the girl was beating the skein without knowing why she was doing the operation. I asked various girls the question, "Why do you beat the skein?" "Because the foreman told me to," was one reply. Another one, "I don't know." So I had to teach the girls why and how to beat the skein. That operation is consuming a certain time. I established a standard of forty-five hundredths of a minute to open the skein, — a cross-wound skein popularly known as "grand reel" — and lay it flat and find both ends. What is the next operation? To put it on the reel. Now, we are all individuals and we have some individuality about our work. Some girls are using from one-tenth up to one minute to put a skein on the reel. So I established a standard by which the girl can put the skein on the reel, in the same condition as she has obtained it through beating without disturbing the ends, in one-quarter of a minute.

The skeins are wound up and new skeins have to be joined, or the skein breaks. There is an average frequency of breakages. I have made time-studies by the thousands to find out what is the real average. In every thirty-two minutes, on the average, a thread will break; provided the skein is properly beaten and the machine up to the highest standard. So that is another operation. Dividing the number of yards on the machine, which was 7,980, by 130, the number of feet per minute at which the winder runs, you get a certain factor by which you can determine how many times a girl has to change

a reel. In the same way, you determine how many times a girl has to beat the skein.

Another factor which came in was the moisture. I found that in the dye-house they extracted the moisture, after dyeing, without a right standard; the yarn was too dry and broke easily. They put in a humidifying system to get back into the skeins again the moisture they had extracted unscientifically; so breaks and time and expense were saved. The cross-bands on the reels should be round, without a knot, and they should be absolutely clean. By giving attention to these factors you can produce a quantity on a Foster winder about 50 per cent higher than the highest standard ever established by Foster or any other machine manufacturer.

I am giving that as an illustration of what Scientific Management in the cotton industry or in the woolen industry can accomplish. I apply the same thing to a dye-house whether I am dyeing by the piece or in the yarn. I can use it for the picker-room as well as for the carding-room, for the flyer-room, for the spinning-room, for the weaving-shed, for finishing and bleaching and so on up to the packing—even for the yard-gangs.

I recently went into a large cotton-mill and had to wait for the agent. I was sitting in the office and looking out into the yard. A carpenter went to the next building to fix a door. A board had been damaged in some way. He first went around and made measurements, then he went back to the shop to get the board, which proved to be too heavy; then he went back again to get help. The whole time required to fix that board, if there had been proper planning, should have been about ten minutes. That man spent nearly an hour and a half. That is again a lack of planning and despatching; whether it is a cotton-mill or a restaurant or a railroad or a government, the principles of Scientific Management can be applied just as well.

You heard Mr. Taylor and Mr. Gantt and Mr. Emerson giving plenty of definitions of Scientific Management, and I am just asking you to discuss what can be done with Scientific Management and proper organization in the cotton-mill.

We have here Mr. Patterson, whom I ask to have the kindness to start the discussion.

Mr. Patterson: Mr. Szepesi has been talking about the operation of spindles by employees, and I want to call attention to a report which has been made to the British Board of Trade, a very interesting report and very comprehensive, which mentions the number of spindles which are operated in various countries. England, I think, has from 3,500 to 4,000 spindles per person. France jumps to between 5,000 and 6,000, Germany a little higher still, while Italy has about 11,000. The United States comes just above England, but has not quite the efficiency that England has.

Mr. Taylor made a remark about sharing the responsibilities. That is a thing which is not done now in the textile mills. The executive assumes a fractional part only of the responsibility assumed in other industries. In these you find planning departments and other kindred departments laying out all the work, and if there are any mistakes it is to the discredit of the management. As a rule, you will find in textile mills that planning is left largely to the employees. The management tell them that they want so many thousand pieces of cloth a week and it is left to the overseer to get it out. He is sometimes told how many looms he can run; sometimes he is not. But the responsibility is not assumed by the management in the textile industry to the degree that it should be assumed.

The first principle of Scientific Management that Mr. Taylor mentioned was to gather in the rule-of-thumb information. I have been working in textile mills somewhat as Mr. Szepesi has all my life, and I find that the information which it is necessary to have is not in the offices. As some of the speakers have said, you must ask the overseer what method is to be followed. This is one of the things which I am trying to do now, to gather the information into the office so that the mills can be run completely from the office. It is a large undertaking. I have not set a rate of any sort and I have been at it for over two years.

One of the ways in which I am gathering this information

is by establishing standards through all our plants for standardizing purposes, also for cost purposes. It is said that the costs are incidental: they are to a certain extent, but they are a very large incident. The prices in textile mills are all made before the goods are sold and they are all based upon estimates. There are few costs used in the textile industry. The costs that they now have are made up semiannually or annually and are based upon estimates which are made at the time the cloths are first introduced, multiplied by the yards made, perhaps, and then an adjustment made to equal the actual expenditures. You will find that method in use in most of the textile mills.

People ask, "What good are costs if they are not got accurately? The goods are not sold accordingly to those costs." That is very true, but there is a deficiency in the textile industry which is a very marked one. We are much behind the steel and shoe industries. We are now where they began. We are not getting our operation statistics accurately: we are only getting our balance sheets semiannually or annually. They can be obtained monthly and are being obtained monthly in two textile mills that I know of, but I know of only two in this country. We have to have, with those, running inventories. Beyond the current costs and the running expenses, the textile mills today have most of the information that is essential, but those two are the stumbling blocks. You have to standardize methods to be up-to-date, and, after obtaining those two, start your scientific methods. But I feel that you have to know what you are doing and have been doing before you can take intelligently those steps, excepting in isolated cases.

It has been stated that the management is the hardest to handle. That is pretty true; I think that is one of the greatest obstacles to be encountered by any one installing new methods. That point was made by both Mr. Taylor and Mr. Emerson. The textile industry is considered one of the most conservative, and I know it takes a great deal of tact sometimes to avoid trouble.

It was stated that in some industries there is one man in three employed on the side of the management. If you would talk of any such proportion as that at the outset with the textile manager, he would not give you a hearing. The cost of installation is probably the first thing the textile man inquires about when investigating any system; and it is a very difficult problem for a manufacturer to approach, because there are no set standards of procedure. An engineer will frequently be asked, "What can you do for me?" He does not know; he has never seen the manufacturer's plant, perhaps; he cannot give an idea what the cost would be; he wants to go in and try. Then the next step is usually to set a limit upon what the first outlay will be. After that he probably makes a diagnosis of the manufacturer's requirements. Following that, usually the cost estimate is made, so much a month for so many men, the items not stated but the gross sum stated; then the manufacturer wants to know whether it is all worth while. That is a thing which he will have to judge for himself. He can tell only whether it is desirable for him to have modern methods and, if he has them, whether he will use them, and whether he has men who are able to digest them and apply them successfully to his business.

Mr. Emerson said that in the machine-shops he found a machine running at an efficiency of one and a half per cent. The arguments which the master mechanic put up to him are typical of what he will get in the textile industry. Do you appreciate the conditions in this industry? Everybody thinks that the need of his particular industry is different from that of any other, and that his problems will have to be met separately. As a rule, the problems in the majority of these various kinds of business are all the same, though called by different names,—talked about in different languages. The solutions are largely the same.

I have been working now for the past two years with the Pacific Mills, and the greater part of my efforts recently has been devoted to preparing for a new, large print-works,

in order that that may be started correctly. The method of procedure has been first to arrange for the collection of all expense, and before that I had to arrange for an analysis of every job in the plant; in all the organization in fact — cotton-mills, worsted-mills and print-works. Those items of the analysis have been all grouped under departments which have been numbered — worsted department, cotton department, and print-works — and then each room given a number under that. There are seven numbers, identical in each room in the organization; these are for overseers, clerical, cleaning, trucking, oiling and general supplies, with another for labor which is not absorbed in any other occupation. A man can go from one room to another; simply ask the man's room number, because the job numbers are the same wherever he goes; he can go from the cotton-mills to the print-works or the worsted-mills, it makes no difference. If he is a master mechanic's employee, there are six other numbers, one each for labor, material, repairs and maintenance of buildings, machinery, furniture and fixtures. Then there are a few numbers assigned for jobs which are peculiar to a department, which are expenses, and still a few others which are productive labor. That book comprises all the jobs in the organization. You would think it would be an immense undertaking to analyze those. Well, when you think that it is all done by the machine which tabulates the United States census, it is not so large an undertaking. It gives us an opportunity to close our costs when jobs are finished, and to keep things cleaned up.

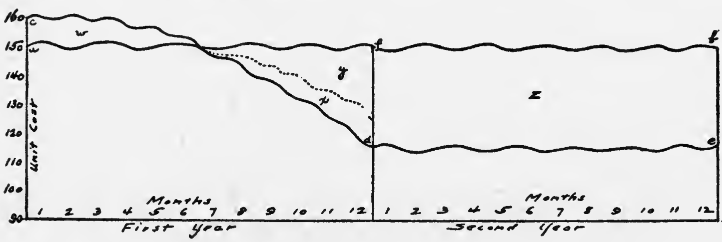
The entire purpose of those costs is that key to the situation, the balance sheet, and that we are arranging to get monthly.

Mr. Szepesi: Mr. Patterson made the remark that the introduction of Scientific Management is a very expensive matter, that you never can tell how long it will take, that you simply go into expenditure and you never know where it is going to end. We generally use a diagram to explain to our clients how much money they will actually spend on an

improvement in accordance with Scientific Management. Suppose we go into a plant and we are asked to reduce the cost to a certain level. If we make investigations and come to the conclusion that it is possible to make such a reduction, we are able to figure out how much it will actually cost. The net cost of introducing Scientific Management is not great; it is actually just borrowing money on the security of future increased returns. And that cost does not usually require cash payment for the entire cost of development in advance; before the installation is completed there comes a critical period when its cost is met by the saving actually effected. Then follows a period when the savings are increasingly greater than the original cost and the difference is credited to the cash outlay at the beginning.

Suppose in a plant the present cost of manufacture is 150 per unit, and it is estimated that a reduction to 115 per unit is possible when the conditions are standardized through Scientific Management.

Standardizing conditions means additional expense which must be advanced. This increases the unit cost to say 160 at the beginning, but it grows less and less as the development work proceeds. At about, say the sixth month of work, the savings equal the development expenditure, and the unit cost — the development cost included — is exactly what it was at the beginning. From then on, the savings being increasingly greater than the development cost, the unit cost declines until, say by the end of the year, development cost ceases and the unit cost reaches the estimated 115 units.




The line *ab* = the unit cost before development. The line *cd* = the gradually decreasing unit cost (development cost included) during development. The line *de* = the unit cost after development is completed. The distance *ac* = the increase cost at the beginning of

development. The distance $df$ = the saving in unit cost at the time development is completed. The total cost of development (savings deducted) is area $w$, which has been advanced and must be replaced. The area $y$ $(x = w)$ = net savings of the year.

The real value of development can be seen in the second year. The development burden has ceased. The advantage, therefore, of the standardized over the unstandardized plant = $z$.

It should be observed that "unit cost" through any period cannot be represented by a straight line, because it varies with the constant variation of manufacturing factors, material cost, labor cost, etc.

Mr. Morrill: When a man says he finds the efficiency of a mill 56 per cent, am I to infer that the average worker in that mill performs only 56 per cent of what the average of all the workers could do, if they were properly instructed?

Mr. Szepesi: No, it means that the management is not performing its duties.

Mr. Morrill: Take the whole plant; not the worker alone, but the worker and management together.

Mr. Szepesi: The worker is never more efficient than the management. If the management is — not unscientific, but what I call unsystematized — the worker is very inefficient. It is not his fault at all. If I say that the plant is 56 per cent efficient, it means that the combination of wastes caused by labor, by disorganization, by material wastes, by unscientific buying, by unscientific selling, all combined together, produce that result. There is a certain plant that I have in my mind, a cotton-manufacturing plant using old machinery. They have old-style spinning-frames; their mules are almost *anno* 1800. Their looms have been running thirty-two years. You can imagine how efficient this plant is. That plant is actually running at, we figured, something like 42 per cent efficiency. We received a request to introduce Scientific Management and we refused it. You cannot take a man who is suffering from tuberculosis in the worst stage and put in a new lung, but when he is at the first stage of tuberculosis you can save him. All that manufacturer can do is to throw out his old machinery and start anew to bring up his efficiency. It is the waste of manage-

ment, not of the worker, which has brought him down to this low figure. They are working with machines which are absolutely not much better than scrap-iron. My experience is that the working man is anxious to make money. In introducing Scientific Management, you will improve the efficiency of the workmen a small per cent, bring it up to between 75 per cent and 85 per cent, but the greatest gain is in preventing leakages. For instance, I have found that in a certain mill many weavers were missing from the looms without reason, and I traced it back to the filling room. In the filling room this concern employed two good-looking girls, and every weaver, when he found himself a little bit lonely — I cannot express his feelings — went down to the filling room with a certain excuse. I transferred those two girls to another department and put in two older women. The efficiency of the weaving room went up 5 per cent. So the object is not to drive the worker but to prevent waste of time.

Take a certain plant running 100 looms; Jones is the foreman, a mighty good fellow, and he is just waiting till the loom breaks down; when the loom breaks down he repairs it. I had a mill where 37 per cent of the looms were idle because of repairs. Our policy is not to repair; it is to prevent. We do not let a loom or a spinning-frame reach a condition where it needs extreme repair; I do not wait until a picker-stick or any other part breaks; I change it; and by examination generally I can, and you can, and any one else in the business can tell in five minutes whether the loom is in condition or not.

As a rule, I give instructions that at every dinner-hour the section-hand is to go over the looms and, if there is a little repair necessary, it is to be done right away. So I prevent breakage, and bring up efficiency. The Northrop loom is very efficient, but still there are cases where the Northrop loom does not come up to more than 75 per cent of what it should do. It is not because the Northrop loom is not efficient; it is because the management is not efficient and does not consider that looms need a certain attention and a

little planning. Prevent breakages, prevent stoppages, prevent wastes, and you can see how you have reduced the cost of a certain article.

There is no part of the textile industry where you cannot reduce the cost. I have a strong example from the South. There is a certain cotton-mill in the South which I have visited, — it had a new building, new machinery, everything modern and sanitary. They are making cotton sheetings which cost them to manufacture twenty-five cents per pound, and they are getting twenty-four cents for them. So they came to us; they sent samples, descriptions, the pay-rolls in every department, and I could not find out why they manufactured for twenty-five cents per unit and sold for twenty-four cents until I made a close investigation of their yarn. The reason why they could not make money was, that they could not account for 10,000 pounds of cotton in one month. They did not know what had happened to it. They put it into the manufactured article, but they called the yarn No. 20 when it was No. 16. Here was the trouble, and with such a leakage no manager, scientific or otherwise, is able to decrease the cost of manufacture. So that is again a case illustrating why some cotton-mills make money and why some cotton-mills cannot make money.

Testing, for instance, is an important factor, and testing today, in America especially, is very primitive. We do not test our material. A man who is buying yarn just looks at it. Also, there is no scientific test of speed. An overseer says, "I guess I will run 120 picks a minute." Why is he running at 120 picks per minute? He has no other reason than that he learned it that way. I came into a mill where they ran ninety-five picks a minute, and I gradually speeded up to as much as 126, and the thing that made it possible was that I was getting less breakages in the harness than they had been getting. So in textile mills you can determine the actual factors just as well as in any other industry. There is no reason why every textile man should not experiment on a certain scale for himself, look into things carefully and

establish standards. He should not permit a thing to be done a certain way just because it is customary to do it that way.

I am going to give you a striking example. In Germany, for some 250 years, at a certain garrison, a sentinel had been sent out every night about five miles away to watch something; he did not know what. A new general with a curiosity like that of Scientific Management was stationed at this post and, seeing the sentinel going by every day, inquired why he was sent out. Nobody could tell him. The general was a little inquisitive and, on investigation, found that 250 years ago there had been a magazine for military supplies on the spot in question. That magazine had been blown up 150 years before, but they had continued to send the sentinel there because they had done so before.

In industry it is the same thing. My father was a mechanic; he was a watchmaker and my brother is a watchmaker. My brother learned the trade from my father. A certain boring instrument my brother used at the same speed that my father did, until I found out that he could increase his speed, because the instrument had been improved. He learned it the old way; he did not have the inclination to look for any possible improvement. So because a certain loom or a certain spinning-frame or combing-machine is run in a certain way, is no excuse for failing to try to bring it up to a better standard.

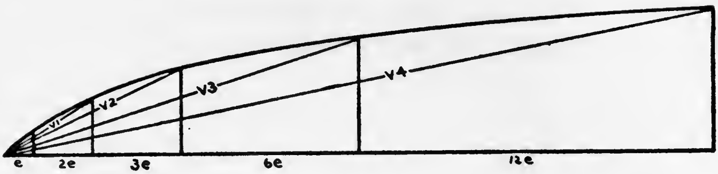
In the textile industry, I think I am justified in saying, we cannot expect any improvement that will greatly reduce the cost of manufacture through machinery. Carding is a very primitive proposition, we all admit. Mule-spinning is a primitive proposition. Who has something better? I do not think I shall live long enough to find something better. Here is the Jacquard machine, more than 100 years old, and it has not been improved in the last 100 years. So we have to accept the present condition, assuming that the machinery may improve only to a certain extent, a few per cent. We have to look, therefore, for other improvement. What we are doing is to compare minutely the present indus-

trial conditions with what they would be under Scientific Management. We are all open for improvement, and we should all do our very best to understand what Scientific Management is. It is not a slave-driving system, and it will never be. The laborer is paid what he is worth, and every one of us is willing to give the laborer the share to which he is entitled.

As to wages, that question came up last week with a manufacturer. He wanted an explanation as to what a bonus is. You hear so much about the bonus; what is a bonus and what is a laborer entitled to? I have no use for a man who under Scientific Management cannot reach the point of 66 per cent efficiency. That man should look for another occupation; he is not fitted for what he is doing. But that means: if it is found, after experiment and endeavor to teach him one step at a time, that he cannot get up to that efficiency, he is to look for another vocation. Suppose I take ten different weights, and take an ordinary worker to move them out; how will he do it? He finds it is easiest to carry the lightest one, and then the next one, and so on until he is able to carry the hardest one. That is the way we teach a man. The boy going to school and learning algebra does not begin at quadratic equations. Reaching college he does not start at calculus; he has to start with the elementary principles.

Suppose I am a manufacturer and employ a weaver; the first thing he does is to change his shuttles. It is an easy task. He may not be able to take care of the warps, take care of the beams, take care of the machine, but he is able to take care of the shuttles. Next he may learn to take care of the reed, and he gradually will become an efficient weaver. So he attacks first of all the easiest unit of the task on which he is employing his skill, and then the next easiest, and so on.

Now to induce this man to learn most efficiently one step after another, and to give him his share of the results of increased efficiency, the bonus system of payment is used. It automatically makes his wage greater as his efficiency increases




Let $e$ = the unit effort to reach efficiency from the lowest, say 50%, to 60% efficiency; and let the effort be twice as large to reach from 60% to 70% efficiency, i.e., let the effort required to reach

from 50% to 60% = $e$
from 60% to 70% = $2e$
from 70% to 80% = $3e$
from 80% to 90% = $6e$
from 90% to 100% = $12e$

therefore the individual has used up efforts at the different stages of individual efficiency, as follows, —

at 60% $e$
at 70% $e + 2e$
at 80% $e + 2e + 3e$
at 90% $e + 2e + 3e + 6e$
at 100% $e + 2e + 3e + 6e + 12e$

Now $\frac{\text{effort}}{\text{result}} = \frac{\text{efficiency}}{\text{reward}}$; therefore

if effort = $e$, Reward $v = e$
if effort = $2e$, Reward $v_1 = e + 2e$
if effort = $3e$, Reward $v_2 = e + 2e + 3e$
if effort = $6e$, Reward $v_3 = e + 2e + 3e + 6e$
if effort = $12e$, Reward $v_4 = e + 2e + 3e + 6e + 12e$

$$\text{but} \left\{ \begin{array}{l} v = \sqrt{1 + 1} \\ v_1 = \sqrt{3^2 + 2^2} \\ v_2 = \sqrt{6^2 + 3^2} \\ v_3 = \sqrt{12^2 + 4^2} \\ v_4 = \sqrt{24^2 + 5^2} \end{array} \right\} \text{units}$$

If bonus for 100% efficiency is 20%, thus the bonus paid at the different stages of efficiency will have the following index numbers, —

| | | | |
|---|---|---|---|
| 50% | 0. | 80% | 6.7 |
| 60% | 1. | 90% | 12.6 |
| 70% | 3.6 | 100% | 24.3 |

and the bonus paid will be — with some slight corrections, —

| | |
|---|---|
| Efficiency 60% | Bonus 0.8% |
| Efficiency 70% | Bonus 2.4% |
| Efficiency 80% | Bonus 5.5% |
| Efficiency 90% | Bonus 11.0% |
| Efficiency 100% | Bonus 20.0% |

So that is the way the laborer is paid, the physician is paid, and everybody in the world. If his efficiency is going up, no matter how much he is paid, he is worth the money paid to him. If he is 100 per cent efficient, he is going to get a 20 per cent bonus. We have two forces; one is the task, the other is his actual ability in the task he is performing. So the wages of a worker can be established and not guessed at, — "I guess he ought to make $8.00 a week" or "I guess he ought to get 5 cents per unit." What the worker is entitled to must be established: then you cannot do him an injustice. So the question of wages and bonus is one which is the hardest to attack. It should be done very carefully, because cutting a wage or a rate is disastrous.

Mr. Davis: In the case which you spoke of a while ago — the good-looking girls — where you made a change of employees from one room to another, would it not have been better for the discipline of the room to have made it a point of discipline instead of making a change? It seems to me that in that case it would have been better for the overseer to have enforced the rules.

Mr. Szepesi: The policy is to prevent. We are only human, and Scientific Management is something which takes a great deal of philosophy and tact and diplomacy to handle. So I cannot say that a man must not go to the room when he has to go. But if I change the situation he will not go any more than he actually has to. So prevention is one policy of every industrial engineer. It is the policy of today. We try to prevent tuberculosis, we try to prevent every disease, we try to prevent industrial depression, not merely to cure it — that was the old system. We have something better — to prevent

Mr. Cardullo: Do you attempt to fix a task in the weaving industry by settling the number of picks and the percentage of time looms are to be stopped, and so on, and then ask the men to make that test and give them a bonus if they get over that?

Mr. Szepesi: Yes, something of that kind after careful study.

Mr. Cardullo: Well, how do you do that; do you have some system of piece-work?

Mr. Szepesi: The piece-rate is nothing less than the market value of an average good workingman based on the conditions and the proper day's work. I give him a certain piece-rate which I want to keep and give him encouragement to do his very best — not drive him, but have him do his very best — and I could not give him more than actual money. They don't care for nice words, and I don't blame them. They have burned their fingers many times. A piece-rate and bonus — a real piece-rate honestly given to them, and the management doing its best to promote efficiency — is insuring the workman to earn that money; and they are going to earn it, but there has to be established a certain rate. Today it is established by cost and certain market conditions without knowing what the proper day's task is. That can be determined only by time-studies.

Mr. Cardullo: You establish the day's task by time-studies before you fix the piece-rate?

Mr. Szepesi: Absolutely; that is the only way to do it.

Mr. Lincoln: How far has Scientific Management, to your knowledge, been introduced in the textile industries?

Mr. Szepesi: I am sorry to say in not more than 1.5 per cent of the whole industry. It is about that. Several mills are taking it up now, but it requires considerable time to develop it.

Mr. Lincoln: Have you actually introduced the bonus?

Mr. Szepesi: It has been introduced in several cotton-mills and woolen-mills.

Mr. Lincoln: Just how do you apply it to spinning, for instance?

Mr. Szepesi: That is a very interesting question. I went into a cotton-mill to see girls attending spinning-frames. I made time-studies and I found that a girl seventeen years old was the most efficient in the whole room. And so I put her aside. I did not want her as a standard, because she was too efficient. I had a variation from fifty-seven spindles, attended by a girl, upwards, and I gave a bonus according to the number of spindles a girl can attend. Some girls are clever and some girls are not.

Mr. Lincoln: Yes; but what is your basis?

Mr. Szepesi: My basis is time-studies, just as well as for looms or for anything else, to determine how many spindles a girl can run on an average.

Mr. Lincoln: I understand it varies with your frames and with the age of the machinery?

Mr. Patterson: And the quality of the stock?

Mr. Szepesi: Yes, but that is all averaged. I determine the unit cost just the same for a loom which I use for a fancy fabric as for a loom used for the ordinary printing sheet. For every one I have a different rate, for different stock and different numbers of yarn.

Mr. Lincoln: You have some standard with which you begin, don't you?

Mr. Szepesi: No, I have to find out the standard. We all have standards in general, but when we start to standardize specific conditions we do not consider previous standards; we consider only how much a girl should earn under the conditions. Maybe my unit will be smaller or will be larger. I have had cases where they established a certain rate, and I had to reduce it to 50 per cent. When the girls were 85 per cent efficient they made as much as 30 per cent bonus with the reduced unit rate. So time-studies and investigations must establish the rate — the right rate — only the operative must earn as much as she did before, and certainly should earn more, because you want her coöperation.

Mr. Lincoln: I should say that spinning would be a very difficult thing to standardize.

Mr. Szepesi: Spinning, I admit, is a very difficult proposition, but the rules of Scientific Management can be applied to cotton spinning just as well as they can be applied to handling pig iron. The difference is in degree. It is a difficult proposition, but it can be overcome by time-studies and by establishing rates and by making experiments as to what is the best condition for spinning a yarn.

Mr. Morrill: How do you increase their efficiency — by giving them more spindles to run?

Mr Szepesi: Sometimes. Sometimes I reduce the spindles to be run. I have known cases where they gave the operative too many spindles to run, and therefore she could not attend them. As I illustrated for the winding department, the spindlage for a spinner should be established just as well,— how many operations she has to perform per unit of spindle, and how much time she has per unit of spindle, and the difference between the two is going to give the result just the same as any other mathematical equation. One girl may be extraordinarily fitted for that work. I have seen girls who are born spinners, some women again who are absolutely unfitted.

Mr. Morrill: If you take anything off them, you have to take the whole side?

Mr. Szepesi: You may probably take the whole side, but you may arrange the spindles differently. You may improve the efficiency of a spinning-room by improving the light, by improving the ventilation, by giving the girl ten minutes rest every day in the forenoon and in the afternoon. All these things will improve her efficiency. There are many factors which you have to analyze very carefully in order not to come to a conclusion which may prove a failure for the mill and cause labor troubles. The standard that would be just and right should in every case be sought for. In many cases, we reduce spindlage.

Mr. Corcoran: It just occurred to me that the efficiency of a cotton-mill, of course, could not be increased very many per cent by any superhuman methods or means of man. Now, on the other hand, in introducing Scientific Manage-

ment there is necessarily brought in a new expense, the planning department with all its detailed studies and figuring. Mustn't you show a saving for the mill right there? Isn't that the stumbling block that keeps it out of a good many textile mills?

Mr. Szepesi: No. The planning department is the brains of the mill. I cannot think with my hands, I only feel with my hands. If you go into a cotton-mill and without any planning department you want to observe facts, whether a certain stock is running or not, you have to feel it. The planning department — the brain — on the other hand actually gives you information as to what the stock is and enables you to make a saving.

Mr. Corcoran: I might put it this way, that a blind woman might make a waste basket, —

Mr. Szepesi: Yes.

Mr. Corcoran: And if you gave her eyes she could not make a waste basket much faster, —

Mr. Szepesi: No, but you can prevent the delays. For instance; in a cotton-mill, say the picker-room or the scutcher is out of condition; you have, probably, an ordinary man with limited intelligence, to weigh every bundle or every roll that is coming down from the scutcher. If the stock is not proper or the machine is not delivering the right production, the difference cannot be seen at once. If you have a planning room, you know that a certain stock, a certain unit, has to go through. Next you find in the planning room that the production is not what it should have been, — there is something wrong. Many thousands of dollars worth of cotton could be saved by discovering the trouble in time to prevent the cotton going through to the spinning-room, by remedying the difficulty at the very beginning. So the planning department is the brain, the nerve system of a mill.

I have seen a certain textile mill where they had a planning department, — a full plan was drawn of the whole mill, and a point was designated for every loom, for every spinning-frame; and for every frame they worked, the kind of goods

they were running and the date when the goods must go through. It is not money thrown away; it is simply establishing a system by which you know things and do not guess. You have a brain for the organization, not merely a tool. Suppose you want to find a certain piece of goods which is somewhere in the dye-house. John is going there, maybe he is around and maybe he is not; and he may be able to find it. But in the planning room, you know that this particular lot will be in the bleachery tomorrow.

Mr. Corcoran: I have had a little experience in scientifically managed concerns, and we have found that, whereas under the old system a point might be stretched to favor a certain customer, yet under Scientific Management all customers, as I understand it, are universally kept at bay until the goods come through of their own accord. Do you think that is Scientific Management?

Mr. Szepesi: No. You may buy a gold brick of the real stuff or you may buy a piece of brass, just shining. So it is up to the particular concern to determine whether it has real Scientific Management or not. One cannot prevent people selling gold bricks. We don't sell them, in fact, we don't promise gold bricks. But I read last week that Scientific Management is taught in twenty lessons at $2 a lesson. So it is a question of the reputation of the man to whom you apply. You may go to a fake to introduce his so-called Scientific Management.

Mr. Corcoran: I might ask that other question of mine again, and that is this: I think you will have to show to textile men that the cost of maintaining a planning department will not be larger than the saving they can possibly make over the present slipshod methods.

Mr. Szepesi: Yes, you have to show every manufacturer. It must be proved that things are actually worth what they cost. I have shown you by a diagram how the expense is repaid to you by the improvements. In the beginning, you have to advance a certain amount for the future account while the plans are developing.

Mr. Russell: When you establish a piece-rate, that is the flat rate for every man in the spinning-room, or the card-room, is it?

Mr. Szepesi: They are all on the same rate; every one has the same chance to make money, but it differs. Mr. Taylor has a certain method of determining rates; Mr. Gantt has a certain method, and so has Mr. Emerson. But there is no difference in the principle; they are only different forms of execution of the bonus system. But every one is getting the same rate. For instance, I may have foreign help at $6 a week. If she is primitive help and cannot understand English, the best way is to make things as simple as possible. I had a funny experience with foreign help. I introduced the bonus system and gave the help a table showing how much bonus they would get for certain efficiency — if you make ten yards, if you make eleven yards, if you make twelve yards, and so on. Before I came into the plant they paid for the edges. Now it was a fancy worsted fabric, and the workmen themselves had to twist on the edges, because they had long warps and the edges went from little spools, so it was customary to pay them for the edges. Every pay-day, every two weeks, the average workman was receiving 22 cents extra for the edges. After the first pay-day under the bonus system, a Pole was making something like $3.50 bonus because he had over 66 per cent of efficiency, but I didn't pay him for the edges. He almost killed me. He wanted his edges, no matter how much bonus he made. So I prefer, with help not speaking English, not to give an elaborate plan, not to tell them what I am doing. I tell him, "If you make so much, you earn $11.22; if you make so much, you earn $14.75." Give it to them in this primitive form, and for his primitive mind it is satisfactory. Foreign help is likely to have imaginary grievances.

Mr. Caswell: Have you found it to be an advantage to tell the foreign help what you are doing, explain to them?

Mr. Szepesi: Yes, I must gain their confidence.

Mr. Caswell: How can you explain these complicated bonus tasks and rates to them?

Mr. Szepesi: It is all up to the workman. First, if I have an Englishman, I say, "John, I will explain to you what I want." But —

Mr. Caswell: Non-English-speaking people —

Mr. Szepesi: We have 85 per cent foreign help, some Greeks and some Poles. I simply say nothing. When the pay-day comes, he sees his pay envelope and finds he is earning more money; and then he gradually is broken in. I write down things in English and have them rewritten in Polish. For instance, instructions for the weaver: "Don't do that," "Do that," giving little sentences in popular language telling him what he should do, what he should not do, and how much he is going to earn. Gradually you gain the confidence of those simple-minded fellows, and they comprehend what you tell them. I know them very well; I was brought up in the old country and I have traveled a great deal in Europe, all through the Slavic countries, so I am familiar with their state of mind. They all have imaginary grievances, and it is my conclusion that 75 per cent of the strikes in America among the foreign help could be avoided by considering them just as they are, as primitive human beings. This is a simple psychological fact; we have to handle human beings as human and handle them in their own way, in their own language. So I do not anticipate difficulties, provided the man is careful who handles that very delicate task of a bonus, which is like a bunch of wasps, — you have to be very careful, to be somewhat of a diplomat, to handle it.

Mr. Caswell: Have you found it any advantage to inform these non-English-speaking operatives each day what they have earned the day before? Or do they have to wait until pay-day?

Mr. Szepesi: That all depends. For instance, I never advise to start with the whole room. I may pick out one or two intelligent foreign men who speak English and let them receive the training in the improved methods. Then very

soon they are talking about and telling everybody that they are making more money, — that is the way I introduce it to the room. When the others see they are making more money, they are anxious to get it — sometimes, sometimes not. Sometimes they refuse even to work under it; they don't want it because they don't understand it; so diplomacy is absolutely essential for introducing Scientific Management. You cannot lay down a universal law or a rule by which you can handle every one. In every mill you have different conditions and you have to adapt your system to the conditions. The bonus should be established only after long time-study, because it should never be changed.

MR. CASWELL: Do you advocate the use of a daily record, a time-card showing the amount of work that each operative has done?

MR. SZEPESI: Both are used, and I advocate both according to the conditions. I have mills where it is necessary, but in many mills it is impossible to get the data. If I have a warp which runs off in two weeks, I cannot tell each man what he is making.

MR. CASWELL: You can by the use of a pick-counter, can't you?

MR. SZEPESI: I have had some experience with pick-counters, and I find that in some mills they are very valuable, but in some mills you cannot use them, and I do not know whether, on the whole, there is a practical value in them. It depends on actual conditions, just as I may have a planning system developed in a certain way, which all depends on the help. I know two mills employing the same help; one is very efficient and the other is not. They are of the same nationality. The difference is that in one they don't know how to handle the help. They try all kinds of improved machinery, but it does not improve matters. I think at the beginning it is advisable to inform the help whether they are improving or not. Then if you see a relapse in a workingman's production, you can improve it right away.

MR. CASWELL: I have not heard anything said about

whether the pay of the foreman of the room depended at all on what his room produces.

Mr. Szepesi: Yes, he is getting a bonus just as well, but not for production only.

Mr. Caswell: For quality?

Mr. Szepesi: The foreman is getting a bonus for production and quality, and it is just. Everybody, I think, even the manager, should get a bonus for the improvement of the plant. He is entitled to it just as well as the lowest helper. It is nothing but an ideal coöperative system.

Mr. Broughton: In weave-rooms do you pay particular attention to the speed of looms?

Mr. Szepesi: Yes.

Mr. Broughton: How do you go about that? Do you take daily readings or twice a day?

Mr. Szepesi: Now if you speed up a loom it is a question how you run it — whether you run it by belt or by direct electric motors. I find that the variation in the electric motors is very great. For instance, if a loom is speeded up to 104, it is run between 104 and 105, and in belting you may have slipping. If you improve the belting conditions, you have absolutely uniform speed of the loom within certain limits.

Mr. Broughton: What would you allow if a room were running 103 picks — 2 picks?

Mr. Szepesi: I would not allow them 2 picks, that is too much. That is more than 1 per cent, it should not be more than 1 per cent. Besides, you have to consider that in a fabric those picks generally equalize; it is shot through, and is shot in, and is under a certain stress. When you go through the bleaching and dyeing and finishing processes in the cotton fabric, you cannot recognize your original fabric, so that one pick makes no difference for an ordinary cotton fabric if I am weaving a high-grade fabric.

Mr. Broughton: Wouldn't you be governed in that by the number of picks you are putting in?

Mr. Szepesi: Yes, when I am picking.

MR. BROUGHTON: How much the looms fall off?

MR. SZEPESI: Yes. That is the best test of the variation, and to overcome it a differential take-up is advisable. If you have proper belt conditions and proper motor conditions, the loom in good order and the take-up gear in good order — sometimes they slip if you don't take proper care — then the differential take-up system insures almost uniform operation. You have to consider, for instance in a big corporation, that one pick per inch amounts to something in a year; one pick per inch is a bonus.

MR. BROUGHTON: How do you get the average, say in the weave-room?

MR. SZEPESI: I pick the weavers out.

MR. BROUGHTON: How do you know she is a good weaver? Do you take time-studies?

MR. SZEPESI: I take time-studies. First of all I see how much money she is making, then —

MR. BROUGHTON: You have no standard to start with?

MR. SZEPESI: No, I am blind when I start and I gradually open my eyes. When I start, I pick out men, — first of all a man who is fairly intelligent in appearance, clean, and with good habits. If he is an Englishman or speaks English, I explain to him what I am doing. I explain to this man what the stop-watch is, and gradually I gain his confidence so that I can make time-studies, and I am able to establish standards. The first time-study of a man is absolutely useless, — I have been a weaver myself, and when the boss came around I was getting busy; I tried to do things very fast. The second, third, fourth, and fifth will probably enable you to establish an average.

MR. LIGHTBODY: I am glad to hear you are a weaver. I want to ask you one question. You select for your first weaver a good, smart, intelligent weaver to get your first standard?

MR. SZEPESI: Yes.

MR. LIGHTBODY: Now, do you take the poorest weaver? There are poor weavers you know; there are weavers who will

do only one-half as much as others on the same work. What do you do with them? You take the high one and the low one and then average them?

MR. SZEPESI: I don't average them. I find out why that poor weaver is not coming up to the desirable efficiency? In many cases, I have found it is up to the manager. So I don't average; I just determine and take, — just as Mr. Taylor said, a good dray horse for hauling coal — a good weaver. If I have foreign help, I take an average man from Europe who never was a weaver before, but learned his trade here. I cannot take a man who comes over from England, whose father was a weaver, as a standard for a Polish weaver who learned the business here. So I take a man who emigrated from Europe and learned his trade here, and is sober and industrious and willing to learn. That is the ideal man for a time-study; not the very good man but the average man you have in your mill. It is also advisable for corporations to do a little work in getting information as to the general habits of the help — to determine average living conditions and deficiencies. That is an index number. If I know that index number, I can tell what will be your efficiency. It is up to the help. Then you can take an average from the average man you have in your mill, after many time-studies. A good weaver is a man who is not all the time busy, who is not always standing at his loom and watching. A man who is happy and whistling around the loom is an ideal man.

MR. RUSSELL: How much time would you spend with the man who is a poor weaver, to instruct him? How far would you go in that respect?

MR. SZEPESI: It all depends on how many applications I have had. If I am in a town where I can get plenty of help, I am not going to bother too much with the inefficient man.

MR. LIGHTBODY: What do you do with him, if you can't bring him up?

MR. SZEPESI: If he is not fit for that particular business, I cannot bring him up to standard, — there are failures among physicians and lawyers and ministers and weavers and

mechanics; you find in every business, men who have missed their vocation. If a weaver comes up to the standard of 66 per cent it is worth while to keep him, because it is a hard thing to let an old hand go, and I don't believe in it; but if he is below, and I cannot bring him up, I must place him in another department. Possibly he is a good finisher; I should try him there; or perhaps he would be a valuable man in the carding department; try him. I am sure that in a big corporation you will find a place for every man.

MR. BROUGHTON: Don't they object to being transferred from one department to another, if they select weaving as their particular job?

MR. SZEPESI: No.

MR. BROUGHTON: Can you put them in the card-room and will they stay?

MR. SZEPESI: That is again a question. If they will not stay there, it is beyond my power to help them; you cannot afford to have a man who is not doing justice to your capital.

QUESTION: How much time do you spend on a weaver?

MR. SZEPESI: It depends on what you weave. If you weave a high-grade worsted, I am willing to spend four months with a man.

QUESTION: Supposing you are weaving cheap print-cloth?

MR. SZEPESI: One week, if you see a man is absolutely unfit for a certain work as a weaver; within a week you may see indications of his ability or his willingness. You can determine in one week whether he is fit for weaving a cheap print-cloth or a plain merino fabric.

QUESTION: I have had some experience myself in weaving, and I had one young man, a Pole, working for me, who could not earn his salt for about three months, but he turned out to be about one of the best weavers I have today.

MR. SZEPESI: Well, that is an extraordinary case.

QUESTION: Under your one-week method you would lose that man.

MR. SZEPESI: No, I would place that man in another

department if possible. I mean by one week, if the man is unable to show any hope for improvement, — don't misunderstand me; if I see that the man is improving a little bit I would give him every chance. For instance, we all differ, and perhaps he cannot grasp a certain idea right away. It took me years to learn to drive a nail, until by accident I found I was hitting it just the right way; but I improved all the time. If he shows any signs of improvement, he will probably be a good weaver, but if he shows absolutely no improvement, no willingness within a week, then he is something which you cannot afford in that department.

MR. WOBBECKE: How do you figure a man's standard when he works only about half a week, whether he is 60 per cent or 70 per cent or 50 per cent efficient? Suppose it is between seasons and you are not busy?

MR. SZEPESI: When he is doing a day's work and is 100 per cent efficient that day, he is put down as 100 per cent efficient. I do not figure weeks; I figure efficiency per hour.

MR. WOBBECKE: You figure according to the number of hours he works?

MR. SZEPESI: The number of hours he works. Any other way would be an injustice; for instance, to a man who is a very good worker and who is sick a day; he is entitled to his average efficiency per hour.

MR. WOBBECKE: Don't you find, as you are going around and making investigations at different factories and discovering these instances of great inefficiency, that the managers are apt to disbelieve you and not have anything to do with it?

MR. SZEPESI: I don't sell efficiency; I am a professional man.

MR. WOBBECKE: I know, but aren't you called out to make inspections?

MR. SZEPESI: Yes, if they call me in. I don't sell it.

MR. WOBBECKE: In case you try to inform managers that there is something wrong in their factory, I suppose they are

likely to say that they have been in business all their lives, and they have an idea they know all about it.

Mr. Szepesi: Yes, many people do that. I had a case where a cotton manufacturer read my articles and he wrote me a letter asking me to see him. He was an elderly man, and sizing me up, he said, "How old are you, sonny?" I said, "I am thirty-one." "Well," he said, "I am seventy-five years old and you mean to tell me how to run my business?" But still we prove that one cannot know everything, and there is no superintendent who can do development; he has no time. There is no manager, no foreman, who can do it; they have no time to do it; they cannot neglect their work. Scientific Management must be introduced without disturbing the mill. Suppose you ask the superintendent to make time-studies and development; he would neglect his most important duty, which is to get the production.

Mr. Wobbecke: Take the finishing room; how do you calculate a man's efficiency there where his work is dependent on the work of another department? Take a man running the nap-shears?

Mr. Szepesi: That is a good question: I am glad you brought it up. I can make great improvements in the finishing department probably without disturbing the conditions, but I start at the foundation. I start at the picker, or even at the storage room, and then go up gradually from room to room in the order of the processes. I cannot introduce standards of operation and standard wages in any department unless all the departments leading up to it are on a certain efficiency basis. Every department is dependent upon other departments — those through which the material must pass before reaching it—and if its standards are established upon the basis of conditions in those other departments which are afterwards changed, the standards become useless and have to be discarded. You start at the beginning, at the storage room; that is the place to start; then go up gradually. You cannot start in the finishing room unless you have improved all the departments before the finishing room.

## III. SHOE MANUFACTURE

LEADER, CHARLES H. JONES
*President, The Commonwealth Shoe and Leather Co., Boston*

MR. JONES: Gentlemen; we certainly should be very much pleased that our trade has turned out such an interested delegation. It is rather surprising, in view of the fact that, as I believe, Scientific Management has made no very great progress in the shoe business. So far as I know, the only concern which has adopted Scientific Management in a large way, and has made distinct progress in consequence of it, is the W. H. McElwain Co. We see representatives here of that company, and many other prominent manufacturers, and we hope to hear from you all; if not with experiences, at least with inquiry, because from the efforts made by the McElwain company and the very surprising and gratifying results which they have accomplished, it does seem that Scientific Management is especially applicable in the manufacture of shoes. I should be glad if any representative of the McElwain company will give us his views or experiences at the beginning of our meeting.

MR. PRESCOTT: As a representative of the McElwain company, I feel embarrassed that Mr. Jones has called upon me so early in this meeting, and to have him state that we are the only shoe factory that has done anything in Scientific Management. I feel rather that the entire shoe business had adopted a good many of the principles, even before Scientific Management was known as such. The putting of the goods through in regular schedule time, the idea of a uniform production, and many of those points, I think the shoe business had been, of necessity possibly, driven to adopt. One of the speakers today quoted from Adam Smith's writings of a century ago, that the best economic conditions obtain when goods are distributed on the smallest margin of profit. I think he would be very much gratified at the present

conditions in the shoe-manufacturing business. I think they affect the manufacture, the jobber and the retailer right through. The consumer today gets his shoes with as little margin as in any industry that I know of.

Now, with regard to Scientific Management, I believe that we have hardly more than scraped the surface. I must say that we have been tremendously interested in Mr. Taylor and his many writings ever since this first came before the public as generally as it has. The fact that business is a science, from the start to the finish, is a thing which as a company we have had instilled into us ever since the formation of the company by Mr. W. H. McElwain. We have realized the fact that each move should be studied, straight from the person who is at the head of the business to the fireman on the engine. We have planning departments throughout the entire organization, beginning with the sales of the goods and following through the manufacturing division, with the floor work made uniform throughout. It is attempted to plan every move in advance. In our labor department we attempt plans which will work out for the uniform earnings of the men, that they may have constant work, and therefore earn maximum wages. We are very positive that we must conduct the business in such a manner that we may have conditions among our help entirely satisfactory to them, that we may have a uniform production and make a uniform amount of work for each man, so that he may get out the maximum amount of work and thereby gain maximum earnings.

I do not know what more I can add. I was not intending to talk today, particularly on the McElwain company. I want to talk more upon the generalities of Scientific Management. I think we must all expect that the next few years will see great advances in the scientific management of all business. The conditions are such that a business to be conducted on a profitable basis must be done in the most efficient way. That comes only by a careful, complete planning, at the very outset of the work.

Mr. Jones: If there are any of the gentlemen present who would like to ask Mr. Prescott questions in relation to the business, probably he would be glad to answer. For myself, I should like to inquire if it has been your experience that under Scientific Management it means an exceedingly large output, at a reasonable or low price per unit, and if your help are generally satisfied. Do you have any trouble in that direction?

Mr. Prescott: They appear to be pretty well satisfied. We have had no trouble.

Mr. Luitwieler: I should like to ask Mr. Prescott,— I understand practically all of your people are on piece-work?

Mr. Prescott: A very large part of them.

Mr. Luitwieler: Typewriters, errand boys, and so on?

Mr. Prescott: You are going a little to extremes, although there is a rather interesting thing in connection with the errand boys, which I might tell you about. We had a great deal of trouble getting efficiency, — quick service among our errand boys. We studied out a plan whereby that work was measured, and a proper unit adopted for the various classes of work; for instance, answering a call on the same floor as the office. We divided it up so that a boy got a certain allowance for covering that distance. Our plan was that we paid the boys an amount a week, and over a certain amount they received a bonus. We further conceived the scheme of dividing the department up into two teams, so that the boys competed, and the result has been that we think we have the maximum amount out of all our errand boys. At the end of the week, the number of merits of each team are posted. The merits are in small units and run somewhere in the 30,000, but it is seldom that one of the teams is more than 1,000 ahead. One week it will be one team, and the next week the other. They are boys of the age of young men in college. The spirit of competition is very strong in them; consequently, it has worked out in a very interesting way.

I think that is a little outside of the line of Scientific Management, but I thought you might be interested in it.

Mr. Donovan: I noticed Mr. Prescott was listening quite attentively to the speaker when he was talking about the store and storeroom. We should like to hear from him on that point, if he is willing.

Mr. Prescott: The plan of a central supply station in the factory we find a very simple matter. Instead of having the supplies distributed in the various rooms in the factory, we have adopted a central station for them, and all findings and similar articles of the shoe are received in that central supply station. As to the amount kept, if the stock falls below a certain amount, more is ordered. Requisitions are sent to the central storeroom by each department once each day and filled. Of course, that keeps the factory itself entirely clear of any superfluous merchandise. The man in charge of the stores is responsible for the quantities ordered, and if any stock is obtained, he is responsible for getting rid of it quickly. It has been a very efficient manner of eliminating waste in that department.

Mr. Jones: It has been a source of great satisfaction to me to see meeting with us today Mr. Tobin, the representative of organized labor in the shoe district around Brockton and that section. Whatever desires we may have in regard to the improvement of service and efficiency will, of course, be largely affected by the attitude of our employees. I have listened with a good deal of satisfaction to all the speakers, and without exception, every one of them has pointed out that the welfare of the employee is the first consideration of Scientific Management. I am curious to know if that sentiment is accepted; if the laboring men themselves and their representatives feel that Scientific Management is really being introduced with full consideration for their rights; and if Mr. Tobin will speak to us along that line, we shall all be glad.

Mr. Tobin: Mr. Chairman, this is the first time in my short life that I have had the privilege of being at college. I came today to learn something. This Scientific Management that we are discussing today is, in my opinion, not as

new as many people suppose it is. It is quite ancient in the shoe business; that is, as far as the shoe business may be considered an ancient business or a modern business. I am speaking now of the factory system, distinct and separate from the old-fashioned small shop.

The factory system in its early inception developed the piece-work system, and growing out of that piece-work system came the scientific method of producing shoes in the swiftest possible manner. I go back myself to the early eighties, when I was working in a shoe factory trimming edges and heels, and in my work, which did not require more than two or three minutes on a pair of shoes, I timed every movement, every operation, with a view singly of eliminating motion and getting out the work in the shortest possible time. I received from my work good compensation for the time being, but it resulted finally in the lessening of the sum per pair, per dozen, per hundred, that I received for my work. I can see in this present-day Scientific Management possibilities that are great, from the standpoint of economy in production. I am not quite clear yet that this system is going to work for the benefit of the race. I am inclined rather to the opinion that the policy of getting more pay for less work for all the people would be better in the long run than the attempt to get more work for less wages for fewer people. That is the fundamental problem which I see in this so-called Scientific Management. It always has an eye single to the proposition of greater efficiency, and Mr. Prescott clearly brought that out in the competition between two groups of boys doing messenger service. Now, to my mind as a humanitarian, that is, to put it very mildly, a vicious system. I do not know how it was conceived. I know how unreliable boys are in doing errands. I have had inconvenience more times than once in that, but I think that this is carried to an enormous extreme. Efficient service could be rendered, and could be secured from boys without going to that extreme.

I believe that the whole theory of Scientific Management can be worked out in other industries as well as it has been

worked out in the shoe trade, and in the shoe trade we have not heard much of it. In fact, we believe that in the modern shoe factory today the management is very, very scientific. No other kind of management could hope to succeed in the shoe business. I believe that the best future of the shoe business will be promoted, — the best interests of the whole craft, both from the manufacturing end and from the worker's end, will be served — by devising a plan of economical production. Economical management will give to the worker the volume of work, as against the lack of volume that halting, hesitating, haphazard management, which is pursued of necessity by the small manufacturer, gives. That reflects upon the workmen, and the difficulties which we in our union have are largely with the small manufacturer. We manage to settle all our disputes with the large manufacturers with more or less good feeling and satisfaction on both sides, but with the small manufacturer who has to run his plant at a disadvantage as against his larger competitor, we must suffer the inroads which he attempts to make upon our earnings and upon our conditions of labor. It is the only way that he can offset the disadvantage under which he labors with his more successful competitor of larger means. It has been my experience, covering quite a number of years, that the small concern gives us the most trouble. It is a source of very great satisfaction to me to know that in the centers, the factories paying the highest rate of wages, in which the earnings of the operatives per man are good, are among the most successful; and there is a reason for that; that psychology which Mr. Kendall mentioned this afternoon is the one which I believe is responsible. Those men who receive the best wages and the steadiest employment are the ones who are giving back the best service in return. They are not always grateful for their employment under good conditions, but as a rule the workmen appreciate good treatment and the opportunity to earn good wages. In so far as Scientific Management can be made to make conditions favorable to the workman, by eliminating unnecessary delay in furnishing the materials,

in assembling the materials to his hands, and by making it possible for him to get out the work without running around the factory seeking some part of the shoe which he is working upon as a means of getting out his day's work, it is a distinct gain to the workman.

Now, in Scientific Management that can be eliminated, and the best results secured in that way. But avoid anything in the direction of the premium system, anything in the direction of saying to a man, "If you do so many pairs a day, we will give you $3, and if you do twice as many, we will give you $4.50." That will never work successfully for any considerable time, and that is one of the difficulties that I see in Scientific Management. The real scientific manager will not, in my opinion, practise that; but he will have many imitators who will seek to apply that method and call it Scientific Management. That is where the danger is going to crop out. I am not interested at all, and would not be interested as a workman, to get $3 a day for doing 100 pairs of shoes, and $4.50 for doing 200 pairs of shoes. Some of the advocates of Scientific Management say that if you do 200 pairs, the employer gives a percentage of the saving as a bonus to the workman, but the manufacturer takes the larger percentage of that gain. Now, that is wrong, because, everything else being equal, the first 100 pairs are done under Scientific Management, that is, under conditions most favorable to getting out 100 pairs of shoes. Then, in my cupidity, in my desire for gain, I try to do 200 pairs. I do 200, and I get $1.50 for doing the second 100 pairs and $3.00 for doing the first 100. That is a system which will not in the long run survive, because eventually men will organize to protect themselves against it.

Do not make the mistake of supposing that because you establish a system today, you are able to say that your help are satisfied. You never can tell, as an employer; you do not know the state of mind of your workmen. I have found many manufacturers who have undertaken to tell me that they know how their workmen feel. The up-to-date manu-

facturer will tell me that he does not know how they feel. That is one thing that they hide from him; dissatisfaction will break out some day, and that business which has profited by a system which degrades the workman will find itself in serious difficulty. I base that prediction upon my knowledge of human nature. The psychology of the working-man must be taken into account, and it does not require an educated man to understand it, either. A very ordinary, and a very ignorant man, but having all the proclivities of the human kind, will look for, and will find, a remedy, and will suffer in the finding of that remedy. That is the natural outcome.

I hear lots of talk in the direction of promoting harmony and good-will between the employer and workman and of figuring out and reasoning out a rational and reasonable way to get a fair return for a fair day's pay. I am against anything that gives a good day's pay for an abnormal day's work. It takes it out of the human frame. Many of these standardized plants are standardized and run today at the expense of the men who are in the business. They are killing themselves with system, and they will eventually kill the business with system. It is not, to my mind, reasonable to expect that a very large force of men can be speeded up to the last notch of their energy and continue efficient for any considerable length of time. Of course, it may be said that those who become inefficient and are worn out can be cast aside. That may be the materialistic view, but that will not last, because, in the end, you must conserve the human race. You must conserve the human race in order to have a market for your products, and all the Scientific Management in the world that leaves out of consideration the ability to consume and the wherewithal to consume, is bound to be faulty.

Now, I said in the beginning that I came here to learn, and not to teach, and what I have said now is just with reference to this Scientific Management, into which I have not gone very deeply. There are some good ideas in connection with it; some excellent ideas. One point made by Mr. Kendall this afternoon, to my mind, is worth a visit here, if nothing

else: the selection of the right kind of steel, to make the right kind of a razor. There is a peculiarity which is true in the shoe business. The selection of the right kind of leather, and the right make, to make the kind of shoe you want, is real scientific management.

Mr. Prescott: I want to say one thing that I think I ought in justice to say, with regard to this plan about the office boys. The competition scheme started from the boys themselves, as a request from them that they might be allowed to do it. I think I should be inclined to agree with Mr. Tobin that the scheme might be pernicious under some circumstances. In starting a thing of that kind, we make allowance for certain conditions, or rather, study the conditions. We might adopt in one place what might not go in another.

Mr. Jones: I was very much interested in what Mr. Tobin said about the condition in the early eighties, when men were paid by the piece. New machines were being constantly introduced. Men were put on by the piece, and when they attained a certain proficiency, and earned certain wages, the price was reduced so they had to hustle to earn what they could have earned originally at the original price. I feel that that was one of the most serious mistakes the shoe manufacturers ever made. They did not at that time consider the rights of labor sufficiently. There is no question at all but that the laborer has a right to share in the improvements brought about by every change of machinery, or anything else in which he is a participant. I believe that is true. I will say for myself that I was one of the offenders. I was in the field at that time. I had the privilege of putting in machinery in our own factory to take the place of hand labor. We did not know what the right prices were. We did not know what Scientific Management was, and time-study, and all these things. We put them in and let the men make their own speed. When they earned a great deal more than their fellows, we docked them so they could earn about the same as their fellows. That is not Scientific Management; it is

exactly the opposite. None of the engineers who advocate Scientific Management would for a moment tolerate that proposition today.

Just one other point. You spoke of anything that could facilitate the work coming to a man, so that he might do a full day's work. That you approve. That is Scientific Management. I remember an experience when we first used lasting machines. They had been in use in other sections a long while before they were used in South Abington. We finally introduced them, and a piece-price was made. The men didn't earn very large wages, and didn't do a great many boots. We made calf boots in those days. I timed one or two of them to see why. I found they could last a case easily in twenty-two or twenty-three minutes, but they wouldn't do over ten or twelve cases in a day of ten hours. I tried to find out why, and I finally ascertained that the things Mr. Tobin describes here constantly happened. A man would get a case to last, supposed to contain twelve pairs. There would be one "left" gone. He would have to hunt the factory over to find it. There would be inner soles omitted, or something wrong about work somebody else had done that put him back. Perhaps he couldn't get the uppers to fit the last he had. There wasn't a plan; the planning department was wholly absent. So finally I took it upon myself to agree with those men that if they would do all the goods they could, I would see that they had stock enough brought to them to keep them busy. That is to say, the lasts were sorted, brought to them and put at their bench, and they did the work. That made a most satisfactory result. They did a great deal more work.

Now, right there, comes another point of Scientific Management. I was entitled to pay for the time of the man who looked up those things for them. That man's time was very much less valuable than that of the operatives. These men were skilled operatives, and a man at fifteen cents an hour could easily do what they were taking their time, worth twenty cents or thirty cents an hour, to do. Consequently, we

agreed on a certain basis, and for years that basis was the rule in our factory. That is, we agreed to find the work and deliver it to the man; then he did it at a price which proved advantageous to him, and also economical to us. Now that, I believe, was honestly Scientific Management.

You spoke of another thing, that the man doing 100 pairs a day, who was speeded up by the bonus system to do 200 pairs, was entitled to double pay; that is, he should not do it for $4.50, when he got $3.00 for 100 pairs. Now, your statement would be exactly true, if the management didn't assist him in getting that result. I assume he could not do that; he could not get double the production unless the management contributed something that helped him. They do contribute something; that is, they facilitate his work in some way; do a part of the work that he did; arrange his machine in a different way, and see that the racks are brought to him.

Mr. Tobin: The facilities for doing the first 100 pairs were the same as for the second 100 pairs.

Mr. Jones: If they were, you are right in your claim that the man should have double pay; but I understand Scientific Management means this: that the man cannot double his production unless the management does contribute to his success, and if they do contribute, and he acknowledge that they contribute, then it is only right that a new adjustment of the reward should be made. But I am not going to discuss that.

We are fortunate in having with us an engineer who knows something about Scientific Management, and if Mr. Tobin did not hear Mr. Taylor last night, perhaps Mr. Godfrey will tell us something about it.

Mr. Godfrey: I hesitated when asked to come in here today, because I have been working on Scientific Management only fourteen months. Therefore, I am just beginning, but I have had the very great opportunity of working under Mr. Taylor's direction. Some of the things questioned I can explain, and one is the question of the changed conditions. There is a tremendous difference between the conditions sur-

rounding the production of the original 100 pairs of Mr. Tobin, and the conditions made possible for the workman today. Let us see what some of those things are. In the first place, under the old conditions they were all the time hunting for tools and waiting for materials. Today there are always men coming up to deliver every single thing required at the workman's machine. After the operation is complete, the move-man takes the finished work and delivers it to the next machine or wherever it is going. There are inspections between each machine, to make absolutely certain that every part is delivered to the machine and that it is properly taken from that machine to the next. And you must remember in this connection that you must pay the salaries of the move-men and inspectors, doing work which the workman used to do.

Now, the question of preparation. For every operation that goes on, there is preparation made. The clearest possible instructions are sent to the workman in the way of instruction cards, tool lists and drawings. Every single task explained as we explain it is a definite lesson to the workman. The tools given him are not only the right tools, but the best possible tools for the present state of the art. If there is a block wanted, the workman does not hunt up a carpenter to have a block made. The right block is provided as specified in advance by an expert. Then, when all preparation has been definitely made, the speed-boss or machine instructor comes to help the man in his work. The speed-boss, by the way, is the man who determines the speed, feed and condition of the machine, *not the speed of the man*, and who assists and instructs the workman. He does not speed him up as is falsely stated time and again.

Now, what it amounts to is this: Scientific Management is the only type of management of which I know, which deliberately takes up not only investigation, but the other side of the problem, *education*. It is a wonderful thing to see the planning room coöperating every single hour with the workman outside, showing him how best to do the work, and encouraging him to do it in the best way.

Take another example. In scientifically managed shops there are times when some class or type of machines will be busy, and another class or type will be idle. There are times when the second group will be busy, and the first idle. Every man in a scientifically managed shop has his capacity. He is not only instructed how to run his regular machine, but he is given an opportunity to enlarge his machine knowledge, thus increasing his range of productivity by systematic instruction with an instructor right on the spot. The instructor teaches him first how to operate machine No. 1, we may say; then a different machine representing a second group; then he is trained on a third type and a fourth; and the workman is paid more as his capacity increases. That is, he is constantly educated to run a greater number of types of machines with his pay increasing as his education advances. Is not this progressive education as far as possible from making automatons of men? We have a planning board and chart by which we can check any given job in ten minutes, and switch the work from one set of machines onto another set of machines. And we know, moreover, which men can do the work on any given machine. Every man is constantly being trained for something better under Scientific Management. He has a possibility before him, which has never existed before, as far as I know, in any other system of education; because, from the apprentice boy who comes in at ten cents an hour, up to the president, every man is being trained, and always knows that the opportunity is open for advancement.

Now, to come back to the question between the management and the man. If the conditions were the same on the 100 pairs and the 200 pairs, it would be absolutely unfair. But you have made all this preparation; you have to have tools and your tool-room; your foreman; your inspectors and your speed-boss, all of whom are instructors who are telling men how best to do their work. The pay of all these men has to come in on the operation; the move-man's pay has to be included; the route-clerk, who told how the work should go from one machine to the other in the

correct sequence of operations, has to come in. There is one man on the planning side to three or five on the working side. These men are producers as much as the men actually at the machine. Why? Because they are making it possible to produce by taking away delays from the operative; enabling him to do his best possible work. How does it come? It comes because Scientific Management is simply seeking for the best possible way of doing any given piece of work. I sometimes call it the doctrine of research. That does not mean anything very big. Primeval man was making a research when he hunted for roots that were edible as against those that were not. We are taking the very best means that modern science affords; all the work that has been done up to the present time in chemistry, biology, physics; in all the great branches of human knowledge; and we are trying to apply it to the betterment of industrial processes, and that means the upkeep or conservation of the man, as much as it means the upkeep or conservation of the machine.

Mr. Tobin spoke about harmony. If a workman does not succeed, we consider that it is up to us to show him how to succeed. Instead of blaming him, we try first to see what is the matter with the management. If a workman can't do the work in one job, find another job for him, put him at that, and educate him there. If a man has a job which needs strength in his hands, and he has not that, Scientific Management does not say, "Throw him out." It says, "Find the job he can do with the hands which he has"; that is, fit the man to the work. To get the maximum production, high wages, and a low labor cost, there is one road. We are working all the time to find what is the scientific law under which a man should work. It is the substitution of exact knowledge for guesswork, combined with a complete change of mental attitude on the part of both employer and employee.

Mr. Tobin: I subscribe to every one of your propositions, but the difficulty is that there are not enough engineers to go around, and there will be imitators.

Mr. Godfrey: Of course there will be imitators; but yet, you wouldn't stop chemistry, which has given us so much, or medicine, which has given us so much, because there might be few doctors or chemists qualified to do the work.

Mr. Tobin: Is this a piece-work system?

Mr. Godfrey: Ours is a task bonus system. The task is wholly different from the straight piece-work system. The task is determined by scientific experiment. It is only determined when everything has been done to make it possible for the workman to do the task.

Mr. Tobin: Has the workman any part in fixing that task? If I explain my reason for asking the question, perhaps you will understand me. I go upon the theory that it takes two sides to make a bargain, and if the workman's task is fixed without his consent, it may be fixed by a man of your stamp, or it may be fixed by a scalawag.

Mr. Godfrey: There you have a difficulty, but I would not set any task if I could not bring the data and convince any man.

Mr. Tobin: I am satisfied of that, but other men might undertake it.

Mr. Godfrey: The answer is that it is not Scientific Management.

Mr. Tobin: That is what I am afraid of.

Mr. Godfrey: I know it, but I say again that neither medical science, biological science, Scientific Management or any other science should be opposed in any way because unfit men may pursue that science. If you will pardon an illustration, take the automobile. That is a very dangerous machine in the hands of an unfit man. But the community guards itself from the unfit men. The joy rider moreover is likely to be killed by his own car. Scientific Management would be extremely likely to prove a boomerang in the hands of a man who tried to use it wrongly.

Mr. Slayton: Mr. Tobin, I believe you are trying the task bonus system in the Douglas factory, are you not, in the cutting room?

MR. TOBIN: No, $3 a day for hand cutting, and $3.50 for machine cutting.

MR. SLAYTON: How about the bonus?

MR. TOBIN: There is no bonus that we know anything about. The point system was abolished two years and a half ago.

MR. SLAYTON: They did try the point system?

MR. TOBIN: Yes.

MR. GODFREY: But did they know what the task was? Had they done this work first?

MR. TOBIN: Yes. They had a certain number of points for each pattern. If the pattern was complicated, they got more points. It was a piece-work system.

MR. DONOVAN: I should like to ask one question; that is, how are we going to decide what is a proper day's work; whether it is that which is set before starting in upon Scientific Management or after? Where do you start in, and where do you find the proper amount to give a man for nine hours work, or eight hours?

MR. GODFREY: No task is set until the "move" is absolutely fixed; until everything is taken away from the machine and everything is brought up to it. That is, the management takes the responsibility of doing all the work it can before it sets a task for the workman.

MR. DONOVAN: What is the proper day's pay for a man? That is what I want to start with; what is the living wage?

MR. GODFREY: That is one of the problems that has not been determined yet and which varies greatly in different places and under different conditions. It is an extremely difficult problem and needs an enormous amount of study; and it is being studied.

MR. MERRICK: It seems to me that Mr. Tobin assumes that any increase in output carries a corresponding increase in effort or labor. It seems to me, from what I have gathered at the lectures, that the aim of Scientific Management is to increase the output, without increasing the effort of the workman.

Mr. Godfrey: And without increasing the effort of the workman to the point where he is tired out. Today, one-half the time, the workman is tired out at the end of the day.

Mr. Tobin: If I make myself plain, I think it will make unnecessary a good many questions. I say that if I have 100 pairs of shoes to do, as a task, for a day's work, which will give me $3, and then I do another 100 —

Mr. Slayton: Under the same conditions?

Mr. Tobin: Under exactly the same conditions.

Mr. Slayton: That can't exist under Scientific Management; you can't increase it.

Mr. Tobin: I am speaking now of the so-called bonus system, and how much that would apply, and how much relationship there might be between that and Scientific Management. I don't know; I confess that; but that is the thing that I am afraid of, that many people will undertake to establish a bonus system. The imitators of the Taylor system will undertake that. That is an old, old story in the shoe business. These tasks have been given, and the man of great speed and capacity will, in his greed for more wages, do twice as much work for half as much more money, under exactly the same conditions. Now, that is one of the things that has made the enormous speed that you will find in the shoe factories today. You go into the modern shoe factory, and you will find every man working at top speed, and still it is said that there is a limitation of production. There never will be a time when it can be said with truth that there is a limitation of production. That is charged up against the shoemakers by the shoe manufacturers, but the fact is that the very reverse is true. I remember the time when I used to consider it a splendid day's work to do 200 pairs of ladies' shoes. In later years, I saw the time when I could do sixty pairs in an hour, if I wanted to go to a ball game. Today, men can do twice as much. That is due to the fact that they have machinery to do it more easily. The rounding machine makes it easier for the edge turner, and other conditions make it simpler and easier to do the work.

Mr. Slayton: I think we all understand Mr. Tobin now. The conditions he assumes cannot exist under Scientific Management; that is, asking a man to do double the task in the same conditions.

Mr. Godfrey: Absolutely impossible.

Mr. Slayton: It could not exist, and it could not be accomplished, I think. There would be such an uprising that I do not think anybody who understands Scientific Management would tolerate it. I think what you say, Mr. Tobin, is right; that from your particular position you have something to fear from the imitators, the unskilled and the unscientific management; but from what we will get from the learned, I do not think that you or the workingman has anything to fear, but everything to gain.

Mr. Tobin: We are in the same position exactly with the quack doctor.

Mr. Slayton: And the professional doctors. We all know after a while the quack doctors and the real doctors. Why? Because the real doctor has a reputation and the quack doctor has, too, but of a different kind.

Mr. Tobin: In the same way that you tell the difference between mushrooms and toadstools.

Mr. Slayton: It is getting late; I think it would be better than to ask questions if some of you would get up and tell what is the strongest impression that has been made on you by the lectures and papers that you have heard. It has certainly made some impression, I think, on every member. We all listened with the inner idea of "How can we apply that to our particular business? How is it going to benefit me in my factory?" We have all made notes, either on paper or in our minds. Now, I think, if some who have been listening will tell what you have got out of this, it may benefit us all.

Mr. Lane: May I ask if, in answering that proposition, some of the men might bring out whether they have studied in their factory any of the present means in the operations, so as to determine what the task should be, and whether this

task problem can be developed and settled by some men in the factory, or whether we must go outside entirely to get an expert in order to accomplish it.

MR. SLAYTON: One thing I heard a manufacturer say,—I won't call him by name. He was making a woman's kid shoe, with patent leather tip, and he found a great deal of difference in the day's work. Some girls might do ten dozen, some might do twelve, and the next day they might fall back to eight. He told one girl that he wanted to see what she could do. He timed it, and found out she could do a great deal more. He said, "Are you willing to do it?" She seemed to be willing. He said, "Instead of paying you $1.50 a day, I will give you $2 a day." She was getting $9 a week, and she doubled her production. She could do it easily. In the first place she said, "Well, there is a certain kind of filler that I used in another factory. If you will use that kind of filler, I can do my work so much more quickly. Another thing; the paper that you are using on that tip is too coarse. If you will use a finer paper, I won't have to use so much filler." So that girl and this manufacturer worked out a condition that made it easier for her to perform more work. She got 33 per cent increase, and he got a saving of 33 per cent, we will say, but the girl did not have to work any harder, because the two of them had found a method by which she could do more. Now Mr. Tobin, I know, would not object to that kind of an improvement.

MR. TOBIN: Certainly not.

MR. SLAYTON: That is the most important feature of Scientific Management. One thing Mr. Taylor said last night, is that in talking with the manufacturers who make machines, he told them that not one out of fifty of their machines is speeded right. Now, that was the most startling thing, to me, that Mr. Taylor said last night. I don't know but my machines are speeded wrong. I know that at times the workmen have put a drag on their nigger-heads so they would go faster, and that they were running their machines too fast and we had to take them off. I know that at other times when

we wanted to speed up we have speeded the machine up. I think there is a chance in the shoe manufacturing business to find out whether our machines are running at the right speed. Now, if the machine can be speeded up, for instance a trimmer, so that it can do a great deal more work, I don't know but that the workmen would be benefited; that is, if it could be done with reasonableness. It would have to be so that he could do it. You cannot put through science, I believe, unless both agree. I believe that you must convince the workmen. I think, for universal success in manufacturing, you must have the other fellow with you all the time. If you don't, you are going to be in trouble.

MR. GODFREY: Absolutely. Mr. Taylor's first consideration is the workman.

MR. WEBNER: The late Carroll D. Wright, the United States Labor Commissioner, said that instead of labor and capital being the same, they were reciprocal. That transaction is the best and most enduring for business which is beneficial alike to buyer and seller.

I gathered from Mr. Tobin's remarks regarding 200 pairs as compared to 100 that he would favor withholding production, for the reason that he mentioned: it would be for the good of mankind. When he said that, I harked back to the days when, twenty-five years ago, I was carrying United States mail on the pony express in Montana. There was a cook at a ranch house there who was very bitterly opposed to railroads. We were about 125 miles north of the Northern Pacific, and I met him one time in Billings, and he actually turned his back on a railroad train. He wouldn't look at it, because he took the position that the railroads had been a curse to humanity. He said, "Look at the number of freighters that carried wheat and oats from Mandan and Bismarck into St. Paul. Look at the number of those men who were put out of business." I said, "On that same line between Mandan and St. Paul, there are this minute more brakemen employed than there were freighters, to say nothing of the conductors, station agents, telegraph operators, train despatchers and a

hundred and one other employees of a railroad." Scientific Management, as I take it, is a survival of the fittest.

I want to ask somebody who knows, if Scientific Management is based largely on the "sheet system"; I assume it is.

Mr. Slayton: It is. The "sheet system," so-called, in a shoe factory is the planning room, the same as it is in a steel shop.

Mr. Webner: I understand. Well, then, the efficiency system does not detract from that sheet system.

Mr. Slayton: No.

Mr. Reed: Mr. Prescott stated that the shoe business has been working under a Scientific Management plan for a great many years, and it is so; but the thing it seems to me necessary to impress on Mr. Tobin, particularly, is that the desire on the part of every shoe manufacturer to improve his shoe business is the desire to improve the conditions for the men. If we are here listening to Scientific Management propaganda at all, it is because we believe that is the only possible foundation on which we can advance. Now, we don't want the man to do twice as much for one-third more. We want to improve the conditions; find a sandpaper that is less coarse; find a filler that is better; find some combination that is better for the workman, so that it is actually less work for them to do twice as much for us, and they are better satisfied at one-third more.

Mr. Tobin: Mr. Chairman, before we adjourn, I want to say that we have in our organization a staff of men who are really experts. We don't call them expert systematizers, but just call them plain organizers. When wage questions arise in factories, they go and look the situation over, and if they can make a suggestion to the employer whereby he can change his system and method of doing work, and if he will act on that suggestion, it is equivalent to settling the question of wages. Hundreds upon hundreds of cases have been settled in that way where the workmen desired an increase in wages. Instead of the increase, we improved the system by a suggestion. You know manufacturers get into a rut.

Mr. Reed: That is what we are trying to get out of, Mr. Tobin.

Mr. Tobin: They follow that year in and year out. If somebody comes and makes a suggestion that appeals to them, they make the change, and it is largely beneficial to them, and to the workman as well. We have had many settlements of wage questions without any increase in wages, but with an improvement in conditions. It is more satisfactory than if there had been the increase in wages.

Mr. Slayton: I know that to be the fact, because 33 per cent of the cases that have come to me from our union shop in the last few years have been settled by that method. It is not because we put in Scientific Management. I was up watching the Goodyear stitchers one day, and I noticed the men who came to wind their bobbins. There was more or less waiting, but what jarred me most was that all around that bobbin-winder there were pieces of thread of different lengths, that those fellows had cut, all waxed. They stuck up the racks; they got into the wheels. I said to the foreman, "Why do they have to cut off as much as that?" He said, "I don't know; they are in a hurry." I said, "Why don't you teach this boy to do it?" Well, as a matter of fact, I asked the men, and it took them about thirty minutes a day to wind those bobbins, because they had to wait, etc. I finally got a boy whom we paid $5 or $6 a week. We taught him to wind bobbins, and he didn't waste any of the thread. We found it took only half a day. We paid him for his work, and increased the workman's wages 10 per cent. They told me, "If you hadn't done that, we would have asked an increase." We saved the thread, which paid for the boy. We didn't ask the workmen to pay us more.

There are a lot of such things, in every factory I believe, that we can all study. We put that boy on a grooving welter because we didn't have enough for him to do on the other proposition. We got our welting grooved all alike, and it was much better. We saved an increased demand from the men by increasing their wages practically 10 per cent, — also

an increased demand from the stitchers — just as much as if we had done it the other way, that is, by giving the task or bonus system. I think there are a great many situations like that.

MR. LAMB: I want to give a little example of Scientific Management, as far as we have seen it. Bottom-stamping in our factory has always been done by a boy. That is, the boy would size the shoes up, then he would bottom-stamp them, and they would go to the treeing room. It was always a troublesome point. We always had what we thought was a surplus of help there, and we began to analyze the operation of stamping bottoms, and sizing up those shoes. The shoes would come to him, oftentimes, in sixty-pair cases. He would sort them from a case on to an empty sixty-pair rack. In other words, he had two racks to sort to. Sometimes there might be more than six pairs that would go on one shelf conveniently. It resulted in our building a rack for sizing up shoes. Then in the stamping itself, we found that the boy was left-handed, and he was working with his right hand, on the right-hand side of his machine. He had a false motion. We changed that.

MR. SLAYTON: You didn't fire the boy?

MR. LAMB: No. We also inquired into the speed of the machine. I presume our methods were primitive, compared to what they may be eventually, but we got the machine speeded right. We corrected a little slipping which appeared in the clutch of the mechanism of the machine. That was brought to our knowledge by the boy's observation, and the final result was that he had his shoes on one side of the rack. He would stamp the shoe and sort it at the same operation. The boys were earning $9 a week. We set a task, and made the bonus $3, and are accomplishing the result. We are satisfied and they are satisfied.

MR. SLAYTON: And they are getting $12.

MR. MERRICK: One strong impression that I have gained from these lectures is this, that it makes no difference whatever, what the shoe manufacturers think of this system. The

time is fast approaching when any man who stays in the game will be forced to adopt it.

Mr. Donovan: Mr. Chairman, I should like to make one statement in reference to a change that was made in our factory some years ago. The machinery being out of line, we had an engineer come in to study how best to keep the stream moving. After we had taken his advice and had the machines rearranged we found we had saved thirty-seven miles a day, on pushing one rack of twenty-four pair of shoes straight ahead,—on not very good floors, at that. So, averaging it on either piece basis or day basis or salary basis, it was just the same. It was a saving for the men, as well as ourselves. To my mind, that is one of the instances of Scientific Management, or efficiency; call it what you will.

Mr. Cushman: You ask for impressions. This is one impression that has been made upon my mind; this is in the shoe business, perhaps, especially. I say nothing about other trades. We have been endeavoring to fix the lowest possible piece-price at which we could get our work done. Now, had we used half, perhaps, of the efforts which we can now use if we thoroughly understood all the methods of Scientific Management, to reduce our cost, we should have bettered the condition of our men, and also should have reduced the cost. In other words, we have made the conditions harder, and put up a fight for ourselves, when we might have had peace and harmony, and accomplished the results the other way, not only to our own advantage, but to the advantage of the men. This thing has happened when we had by a quick man fixed a low piece-price, and were satisfied with it. We left that thing; that was the end of it. Now, we are petered out; that man was not given another job. He was not attracted; that did not represent a yearly wage to him; it simply represented one day's work, or two days' or a week or a month, whereas he had to have bread 365 days in the year. Now, that has been the strongest thing that has come to my mind, the duty that we owe to ourselves and to our men to adopt this system, for just that one thing.

Mr. Reed: I should like to ask whether in piece-work or in day-work it has been easier to establish in the workman's mind the fact that he was to benefit by the scientific study.

Mr. Godfrey: My idea is that in the piece-work it has been easier.

Mr. Reed: I should like to ask how you proceed. Suppose a man is earning by the present piece-price $2.50 per day. What is the first move?

Mr. Godfrey: The first move of any work that is to be changed is the deliberate study of the workman's environment. Every possible effort is made to do away with all the nagging which the workman is suffering from. There is no one item that takes more out of the average workman than not having the things where he wants them. All such things are, as far as possible, smoothed away. There is a preliminary cleaning up. There is a deliberate study made of the conditions under which the workman works and the assumption of all sorts of burdens by the management which were formerly carried by the workman.

When these changes have been made, the laborer who has seen you working and doing these things realizes that you are doing the fair thing. When these things have been done you will begin to get the change of mental attitude, which must come before Scientific Management can exist.

Mr. Tobin: You give an increase of wages to begin with?

Mr. Godfrey: To the experimental men.

Mr. Tobin: It is the common practice in shoe manufacturing to get the workmen to agree to do work under a changed condition, on the promise of certain results, and instead of giving a premium or extra wages from the beginning, he gets reduced wages.

Mr. Godfrey: We are not trying that at all; we are experimenting. We tell the man with whom we are experimenting, "Half of what you are going to do may be thrown aside." We don't try to make him do anything except to have him help us to find out the truth. We simply want to know what is the right thing. We try things that we know

are going to be wrong, sometimes to see how far they are wrong.

Mr. Tobin: The company, the firm, is standing whatever loss there may be?

Mr. Godfrey: And charging it to the experimental expense.

Mr. Tobin: It is the practice in the shoe business to ask the workmen to bear the expense. Is that a fair statement?

Mr. Donovan: I hardly think that is fair. They might, in rare cases, feel that way.

Mr. Reed: Most of us have blower systems in our factories to take away the dust. Some of them are efficient, some are not. We think the atmosphere is not right in the room. It is not for our good, or for the good of the workmen, to have it that way. I, for one, think of putting in a new one. I propose to do it right, if I can find a man to do it. The finishers are working in a dusty atmosphere. The dust is not going out in the separator. It is flying all over. They are earning perhaps $2.50 a day. And now, suppose I try to see what I can do to increase their efficiency. I say, "We must have a clean workroom. We will put in a new system." Suppose we find the system works to perfection. The curtains are clean, instead of dusty. The whole outfit is a success from that point of view. What is the next step? We have bettered the condition under which that workman does his work. The next thing to my mind is the efficiency condition under which the man can finish the most bottoms; almost like the shoveling proposition.

Mr. Godfrey: There is your question.

Mr. Tobin: That is not the question I mean at all.

Mr. Reed: No, but that is the question that confronts every manufacturer in trying to apply Scientific Management.

Mr. Tobin: Suppose a manufacturer wants to change from day-work to piece-work. He says to the workmen, "I am going to make this change. You work a month, and I will pay you so much. If it is not all right, I will increase your wages."

MR. GODFREY: The first thing that is to be done under those circumstances is to get at the task idea, to get a definite record of every workman's performance, to tabulate those performances, and to have the tabulations go back to the foremen of all the large departments, so that they may examine them.

MR. MERRICK: Suppose a dozen workmen are in a line, and they have decided that $15 a day will be the limit. How are you going to determine the fair basis?

MR. GODFREY: If you get the records of every department and every man in that department, you have a beginning. You have the workman's attitude towards the task; what he has been doing. There is your basis.

MR CUSHMAN: This involves an account of every individual machine and every operator?

MR. GODFREY: Every one, and those records come in on the time-cards of the operatives. This is both day-rate and piece-rate. Every record that goes out has the stamp of the time and the man's labor. The man fills up everything else himself, signs it and sends it in. Of course it is inspected. Then all that information is charted, and you can see by the swing upwards of the graph where your production goes. That chart may be made by a $10-a-week clerk. Don't put your Scientific Management man to collecting record data.

MR. DONOVAN: In the installation of this system you take one man at a time?

MR. GODFREY: One man at a time.

MR. DONOVAN: And pay no attention to anything else until you get him where he is wanted?

MR. Godfrey: Until he is where he is wanted. There is no gang-work.

MR. REED: Assuming that your man in charge of the scientific analysis arrives at a conclusion that a given operative has reached his maximum under certain conditions, what is the next?

MR. GODFREY: You see if your experimental man can repeat it. Then you are getting towards analysis and time-study.

Mr. Munn: That is to ascertain your present condition.

Mr. Godfrey: And with that should be some record of the new work. In the machine-shop all machines are analyzed. That is one of the first steps. Mr. Sanford E. Thompson of Newton Highlands knows more of this than I. I should be glad to have him tell you of it.

Mr. Thompson: I don't know whether the machinery that I have in mind would come, perhaps, nearer the machinery that you have in the shop that is not standardized. Let the shop be on piece-work or on day-work, and following along the scheme that you have outlined, I would say to a man to study that machine and to determine as far as he can by his observation the way the machine is operated, and any changes that can be made to make that machine more effective. This, of course, is assuming that routing is going on, and that material is coming through to the machine and going away from the machine in proper fashion. Then is the time to put on your time-study man to get at the actual task.

Mr. Donovan: As a usual thing, Mr. Thompson, how long does it take to work up to this? How long a campaign is necessary?

Mr. Thompson: Before you begin to take your task?

Mr. Donovan: Yes.

Mr. Thompson: That depends entirely upon your present condition. In doing lately some outside construction work, we have got on tasks within two weeks. We have been doing something on inside work where we didn't begin tasks until it had been going about a year and a half. There you have your extreme variation. It depends upon the simplicity of the work and upon how thoroughly it is organized. The point is that, before you can do any task work — get the men actually working on the task — you must have the work in such a way that the material all comes to them; that you know not only what material a man is going to work upon, but after it goes away from him, it must be kept straight. In other words, you must fix the working of the machine and the work of the man. Of course, in a good many shops —

in shoe shops for example — I suppose the material is pretty well routed so you do know the work of your machines. It might be in some cases in the machine-shop that you could get down to your task work pretty soon. Shouldn't you think so, Mr. Godfrey?

MR. GODFREY: I should judge a good many of your tasks would come very easily.

MR. THOMPSON: I suppose you understand Mr. Taylor's principle, brought out in his different writings, — the separation of the operation into the individual units?

MR. DONOVAN: That has all been completed to a great extent in the factory. Now you are going to subdivide that. Is that the idea?

MR. THOMPSON: Mr. Godfrey was talking of the task as a whole. He did not take up the detailed study of the elements concerned in an operation. I might say as an extension of what Mr. Godfey has said, that we study the individual operations on a given machine.

MR. MUNN: The first operation might be taking a shoe from the rack, for instance, and the next putting it into the machine. Isn't that what you mean?

MR. THOMPSON: Yes, taking the shoe off the rack would be the same for all kinds of shoes; putting it in the machine would be the same thing for all kinds of shoes, you might say. The sewing would vary in the different sizes, and it would vary with different shoes. I don't know anything about the shoe business, so I am speaking in a general way. If your leather is thick, I suppose it might be more work to sew it. Then taking out the shoe would be the same for each machine. It is a very crude illustration, but the point is that when you come down to time-study, you have in any general operation perhaps three or four or half a dozen operations that are the same for different classes of work, and two or three operations that vary. When you have a different material, all you have to do is to time those few operations that vary, and then by a combination, you can get the work for any material, or any kind of work that you have. That

is, you can tabulate that and put it on a table so that you will have the unit.

MR. MUNN: Would it be possible for you to make a chart?

MR. CUSHMAN: A tabulation of these operations in their order?

MR. MUNN: A tabulation of the things that would be done in observing an operation; that is, the machine, the speed of it; all the things we have talked over here, for instance, in their regular order?

MR. THOMPSON: I was thinking whether you could make a definite tabulation that would be applicable to different machines. Each one is a study by itself, in a way. For instance, you must study speed by itself. That, of course, is one of the things, but every machine has so many different problems it is pretty hard to tell just what to tackle first, and how to study it. But having got your material, and your men so they are working in a uniform manner, you begin your time-studies. I was thinking what would be the best class of work to illustrate time-studies. Well, perhaps you might take, for instance, paper cutting. We have a cutting machine, a table with a cutter across, and the paper comes to the man on one side. He lifts paper to machine; adjusts pile on machine. Then the mass is cut. Then he removes his paper. That seems like a very simple proposition, but, for example, on a cutting machine the machine will cut a certain thickness. It will cut, perhaps, five inches in thickness, but if the sheets are large a man can't handle that entire five inches. So he must take, say an inch of paper, and put it on the machine, and then another inch of paper and put it on top, and if there are six inches, he will have six lifts. I am speaking of an actual case, an actual problem that came up to us. We were supposed to put a cutting machine on piece-work, and the people who asked us to do it thought it could be done in a few days' time. Now, suppose that that paper is 48×60. We will have, as I say, six layers of one inch thickness. Now, suppose you have paper 48×48. There he can take an inch and a quarter.

Suppose you have paper that is glazed; you can't take an inch, because it works differently; you can only take three-quarters of an inch at the same size. There you have a lot of variables to study. When you come to take off the paper, you take a different amount. The man can handle it more easily, and does not take the same number of lifts. When you come to this one machine, you have to study the quality of the paper, the amount a man can lift, the thickness of the lift as governed by the quality of the paper, and the total maximum cut that the machine can make, which sometimes varies with the quality of the paper, too. In other words, some kinds of paper you can cut six inches; other kinds work differently under the knife, so you can cut only five inches. There you have your variables, and having studied those out, the paper, as it comes to the machine, has slips of paper in it to tell how much a man should take for a cut. It is divided up and is counted off before it comes. It has to be counted anyway. They simply put in a paper in the right place, so that instead of his taking, as usual, four inches in one cut and six inches in another cut, he takes six inches in every cut; that is, he puts six lifts of paper on each time, instead of putting four lifts some times and six others.

Mr. Merrick: Why couldn't that paper come to the machine on an adjustable bench, to cut the proper thickness, and to slide it and lift it; go to the cutter on a rack that would lift four or six?

Mr. Thompson: It might, with some kinds of paper, but where you have large paper —

Mr. Merrick: Suppose the rack were so adjusted that you could put on a three-foot pile of paper, and the paper was three feet below the cutting-knife.

Mr. Thompson: That is just one of those things that you want to study out, to see if you can make those changes.

Mr. Merrick: We wouldn't let him lift the paper.

Mr. Thompson: One point, just to illustrate the difference in your time-studies. Suppose we have a 60×48 and another 48×48. When you come to your time-study, as a general

proposition, you will find that a man can lift one-fifth more of 48×48, so that your time, which is based on pounds lifted, can be obtained for any number of pounds of paper. I don't know whether I make that clear. Suppose we take time-studies on lifting one inch of 60×48. Then he would lift one-fifth more of 48×48. In other words, the size is smaller, therefore he could lift a greater thickness in the same time. That would have to be studied out by taking occasional times; for instance, taking the time on 72×60, and another time on 48×48, and another time on 24×24, and plotting them, so as to give the curve. In that way, you get the time per lift for any size paper. It is probable that it would work out the same per pound. My point that I want to emphasize is just this, that a great many of these items are the same in your different operations.

Mr. Donovan: If you eliminate the other operations, that man can keep on cutting more steadily, if the paper is fed to him.

Mr. Thompson: Yes.

Mr. Donovan: So that in subdividing the job into four sections, when the machine was being used, say, only 40 per cent of the time, he is enabled to use it 80 per cent to 85 per cent of the time if the paper is fed to him, taken away, etc. That is, a skilled laborer would double his work, and the unskilled would bring it to him. Is that the scheme?

Mr. Thompson: Yes.

Mr. Donovan: When you have nine skilled men and they are replaced by unskilled men, what becomes of the nine men who were earning skilled men's wages? Say that cutter was earning $20 a week, and he was only working, actually, 40 per cent of the time. Now, if he cuts 80 per cent or 85 per cent of the time, he is doing the work of two, or two and a quarter, cutters. What are you going to do with those you have eliminated?

Mr. Thompson: Then you come to the same problem that Mr. Godfrey has been discussing tonight. You put them on other work.

Mr. Donovan: If you are employing 1,000 hands, say?

Mr. Slayton: Mr. Taylor's lecture last night answered that question, I think quite thoroughly; that when the cotton machinery was put in the mills in Manchester, England, for the first time, the people who had been doing the work by hand thought their life job was taken away, and they did just what you or I would do. They broke into the shop and destroyed the machinery. But the cotton machinery stayed, and now today it has become so cheap that the common laborer wears a cotton shirt. In those days, he could not wear a cotton shirt. It has always proved that where labor-saving machinery has been put in, it has increased the production capacity, so there were more laborers used. Another thing, by materially cheapening the cost of a manufactured article, it widens the market.

Mr. Donovan: Increases the demand for it.

Mr. Godfrey: The trouble has never been in throwing the skilled laborer out of employment; it has been in getting him to do the job. It has actually acted the other way. Your skilled men are hard to get.

Mr. Merrick: Isn't this the fact, that in the case Mr. Donovan cites, the paper cutters are skilled in that one job, and the manufacturer hasn't any room for them anywhere else in his factory except cutting paper, and he reduces his paper cutters say from twenty to twelve on account of more efficient work? Now, why don't we admit right away that those eight men have to find another job? Why don't we admit that those men must temporarily suffer?

Mr. Thompson: I was talking, in the factory where Mr. Gantt has been, with a mechanical engineer who was connected with the factory; the talk had nothing to do with Scientific Management in any way. He was talking about his output from year to year. He said the curve ran up in quite a sharp line the last two years. It has been going up very sharply. I said, "What have you done? Have you increased your building and your force?" "No," he said. "We have just the same force that we had before, and just

the same building, but we are turning out double the work we did before."

MR. DONOVAN: Suppose that by increasing your efficiency you can produce the same number of shoes in a third shorter time, and that the natural growth of the business is not enough to allow you to replenish the orders. What are you going to do then for the shortage?

MR. GODFREY: Your sales curves are going to determine that to a large degree, because, while you are getting data for everything else, your sales department must get busy and help along.

As regards the eight men mentioned, the old idea would be: "Those eight men are no good. We are sorry, but there is nothing more for you. Get out." I can't say that all those eight men would be employed, but there would be the hardest kind of a try to find what those eight men could do. I believe you would find every man satisfied with his new job.

MR. DONOVAN: We are not letting down on our sales now, we are selling every pair we can.

MR. SLAYTON: All those eight men are not going to be eliminated, because you are going to have more supervision.

MR. GODFREY: With Scientific Management there are a lot of positions for the skilled men. One of the men will be an instructor, others you take into the planning room to do routing. As a matter of fact, I do not know personally of any case where work has not been found for every man. Somebody will say, "That man is too swift; he ought to be doing something else." There is an opening in another position, which is at least as good as the one he leaves. It is adjusting the man to the job, where in the other case it was a sifting out and a survival of the fittest.

MR. DONOVAN: If you are using all these men, and in addition several more, whom you will hire for minor positions, why isn't your production costing you more than it was when you started in?

MR. GODFREY: Because your production is greatly increased. A very large proportion of your production cost

is the overhead expense. By every additional pair of shoes you put out, you are reducing your overhead expense per pair.

In the second place, in every factory there is a certain natural shrinkage, which goes from 10 per cent to 15 per cent, and the changes of men have come almost entirely from that floating population. The best thing we can do is to speak from experience. Don't you imagine you lose 10 per cent of your operatives in a year?

MR. DONOVAN: Oh, yes. I think so. I think that is conservative.

MR. GODFREY: That 10 per cent which drifts is not in the place it is needed. We can fairly well leave them out of the question. As regards the rest let me give you an illustration of what happened a while ago. A mill was being organized under Scientific Management, and in a certain room there were about forty girls who were put out of employment in reorganizing that room. The Woman's Club of the town, hearing that forty girls had been dropped, became indignant, and as the engineer in charge was in town, they sent a delegation of five ladies to him. He listened, and said, "This is very sad. If you will go and get the names of the girls who have been put out of employment, and just bring them to me, I will see what I can do." The engineer saw nothing of these ladies for some time, but later he saw three of them at a reception and asked them what was the matter. The delegation was forced to confess that the girls had all found jobs, in the same plant or in other places.

MR. LUITWIELER: I think we are very much indebted, both to Mr. Godfrey and to Mr. Thompson. We have worked about twelve hours today, and I don't know what Mr. Tobin will fine us.

## IV. PRINTING AND PUBLISHING

LEADER, MORRIS LLEWELLYN COOKE
*Consulting Engineer, Philadelphia*

MR. GRAY (Secretary of the Tuck School): In the temporary absence of Mr. Cooke, we have asked Mr. Edwin S. Browne, of the Curtis Publishing Co., Philadelphia, to lead the meeting.

MR. BROWNE: I am sorry that Mr. Cooke is not here. He seems to be in demand at several discussions at the same time. The function I am about to perform seems to me decidedly like that we heard about yesterday afternoon, of the fireman on the oil-burning locomotive on the Santa Fé road who sits with his thumb and finger at the flow of the oil, and you others will be the mechanism. At the Curtis Publishing Company the work of establishing Scientific Management is in the very early stages, so I scarcely feel qualified to give our experience as of value for application in another place. Discussion and exchange of views on problems that are current rather than finished, seem to me sometimes more helpful than a lot of detail of what has been done by some one who has gotten by the difficult period and, consequently, looks upon some of his difficulties through the kind of lens that diminishes things of the past.

No one connected with the printing business can fail to realize the complex nature of the problems of management. There are so many phases in the business itself; the kind of product, unionized labor, the contrast between the miscellaneous and the one-product shop; we have almost as many problems as you find in the various kinds of machine manufacture.

There have been a number of things that have appealed to me. Some have been very distinctly emphasized by what has been said at this conference. Mr. Kendall suggested this afternoon a consideration of the psychological elements.

The different kinds of labor, for instance, appeal to me as a point in which methods can be elaborated beyond what I believe they have been. It is in connections of that sort that very possibly lies a large field for combination with academic investigation along the same line. There is so much of that sort of thing which is ready for application to real industrial problems. Of course, in the printing and publishing business we have so many operations in finishing, which depart so far from the orthodox elements of the printing line, that there comes a wider and wider scope for the development of the management which covers the complexities as well as the simpler elements of the printing itself.

Mr. Vawter: Do you know of many plants which have adopted Scientific Management?

Mr. Browne: I should hesitate to say what the number is. They are very few. That is a question I should like to have Mr. Cooke answer directly.

Mr. Vawter: Do you know whether any which have adopted it are doing a miscellaneous business?

Mr. Browne: The Forbes Lithograph Company of Boston is establishing the Taylor system in its entirety. Of course, it is in the preliminary stages, those stages which represent the most difficult operations of the work. Mr. Cooke himself is engineering the work there. You can judge very readily how far the work has been extended at the Plimpton Press by what Mr. Kendall said this afternoon.

Mr. Vawter: What is the character of the work produced there?

Mr. Browne: Printing and publishing, books almost entirely. The Forbes Lithograph Co. does a large general printing business. Is Mr. Rowe of the Plimpton Press here? If so, we would like to hear from him.

Mr. Rowe: Our work is composition, printing and binding, and our first step along the line of Scientific Management was in connection with the binding. Two or three years before this movement started, we had reached the second type of management which Mr. Kendall described this after-

noon, and some of us thought that we were doing pretty well at that point, but the introduction of Scientific Management is producing much improvement. Mr. Kendall has suggested something of what it is capable of doing in the different departments.

MR. BROWNE: Have you the bonus system established? You have it in the bindery?

MR. ROWE: To some extent.

MR. BROWNE: Have you made any attempt to establish the bonus system in the press-work department?

MR. ROWE: No, not in the press-work department.

MR. COOKE: A conference with Governor Bass kept me from getting here in time for the opening of this meeting, and I want to apologize to you all for not getting here on time.

MR. BROWNE: I have announced to the gentlemen here that you had contemplated talking to them, and as a penalty for your being late, we expect to hear quite at length from you.

MR. COOKE: It is pretty late, and I had not thought to say very much, but there are a few things I should like to say which will take about five minutes; then we will proceed with the informal discussion.

It seems to me that in the discussion of Scientific Management in the printing industry you must consider the nature of the industry as compared with others. The introduction is going to come, in my opinion, very slowly, for the simple reason that the census returns show that the number of establishments is increasing rather than diminishing, and that the average size of the product of the printing plants between the years 1900 and 1905 went down rather than up. That means that the process of simplification going on in other industries is probably not present in the printing industry to the same extent. Whether that will change as years pass we cannot tell.

Take the electric light industry, where the gathering of control into a very few hands has given rise to the National Electric Light Association with their laboratories and experi-

mental work, so that the gain of one plant is almost immediately made the gain of another. If a man wants to get a lamp tested, he sends it to this laboratory. It is tested there and the other companies get the result of that examination very promptly. That centralized control in the printing industry is absolutely lacking, and is something which must be considered in connection with the question how Scientific Management can be applied to it.

Another point is the natural conservatism of the printers. I suppose that comes from the fact that there are so many small, isolated plants. We are more like farmers. We haven't the spirit of coöperation to the extent that a good many other industries have. You can see that in the slowness with which the cost idea has taken hold. I have a book, which I prize, that I bought in '89 for $1 of Isaac Blanchard in New York. It is called *Blanchard's Complete Cost System.* I bought this twenty-two years ago, and the system outlined in that book is almost the same as is now being put out by the National Cost Congress. Of course it has been revised, and many obvious things cut out; but from the standpoint of philosophy, it is the same thing. Mr. Kendall has eight men in the country now trying to introduce a cost system born twenty-two years ago.

I do not know of any branch of the industry which is not absolutely dominated by what mathematicians call "trial and error." Perhaps the best example of it is the title-page. For instance, a man goes to the case when he is given his copy and picks out a letter in some face or other, sees whether it will go in the line, or sees if it looks right when it is in the line. If not, he distributes it and starts all over again. Now, with Scientific Management that would all be done in the proper way. He would have absolute instructions as to what to do, and when he put 3 or 333 characters together they would fit. We can't see how it can be done, but it will be done, because more difficult problems have been solved in other lines. That same thing applies to every part of the work in which we are interested.

The greatest single difficulty I know of is the foreman. The foremen in the industries connected with the printing business are the most competent I come in contact with in my industrial practice, and we demand more of them than is demanded of foremen in any other lines. I think the foreman of the composing room is the most abused of them all. We have trained him to expect to perform so many more functions than it is possible for him to perform, that I think he is the most difficult problem for the average man in the printing business to face.

We are going to make the foreman, as a matter of fact, a bigger man than he ever has been. But as long as he does not see it that way he does make a difficult problem. Unless you have had the experience that goes with the practice of industrial engineering, and know how gradually to take away from the foreman some of the things he has been doing, and in this way give him more time to perform the functions that need his personal attention; unless that can be done for a period of years, you will find at the end of two or three months, or two or three years, that that foreman mentally is the same individual you started with; and without his coöperation, without his willingness to have some of his functions taken away in order that he may devote more time to the things that are left, the solution of the problem is impossible.

I don't think I am exaggerating when I say that the average superintendent of a plant, the average foreman of a department, ought to devote only 10 per cent of his time to the things he does now; in other words, he floats in about ten times as much work as he can really do.

In my opinion we are now engaged in a work that cannot be stopped. It has gone beyond the point where it could be stopped. Results in printing establishments have been too notable and too successful to allow the thing to stop.

Mr. Smith: What success have you had in the cylinder press-room problem?

Mr. Cooke: The press-room problem is the big problem of the industry, and we haven't really touched it. I will not

say that we haven't made any impression upon it. I have never been afraid of the press problem as some people are. I have felt that it is the big, difficult problem in the sense that it is a long problem, and is going to involve most radical changes in machinery and methods. I was told two years ago by a man who, I think, is perhaps the best designer of machinery in the country, that the printing-press is built on fundamentally wrong lines. I have some idea of what he meant by that. We haven't got far enough into it to know that this is true, but I believe the cylinder printing-press is going to be materially altered before we get much farther along.

In the bindery, in what we call finishing, the operations are all right on the table. They are comparatively simple; the number of conditions that have to be controlled are limited compared with those in the operations of the cylinder press.

I think the setting of type by the monotype and linotype machines has brought about a revolution, and it will not be long before all hand composition disappears. I would not advise any time-study on setting type by hand; I should absolutely eliminate that, because when we get some of the other things out of the way, that will not be a problem.

In the setting of type I personally have done some work, and have had a man associated with me on it, trying to determine the character of the problems which must be solved. If we take the length of a page, we know by setting certain type together — eight, ten or twelve-point, any one of them — and adding the type, the space it will occupy. For example, if you set the words "Tuck School of Administration and Finance" in thirteen-point Scotch we know how long a space it is going to occupy. This is an easy thing, — we have got to the point where we can tell within 3 per cent or 4 per cent. Probably if you could give an advertising agency tables by which they could lay out their copy, they could determine before it is sent to the printer whether it could be set in one face of type or another; making it unnecessary to tear it out

four, five or six times as is usually done. That would simplify matters a good deal, particularly the advertising matter. It is only a question of time, with such men as Bancroft working on it, before practically all that type will be set by machine. I do not mean that it is coming tomorrow. I understand the monotype machine can set thirty-six-point type.

Mr. Fuilder: Do you not think the part of Scientific Management which applies to the management end most directly is just as easy to apply to a printing establishment as anywhere?

I am a publisher, a printer. Now take an example. We have a book to be set up in ten-point type leaded one and one-half; we give it to the printer with those instructions; and the job comes back to us leaded two. We have another job and mark it to be set up in nine-point type; and it comes back eight-point, and the office is out the job. Now what are we going to do about that? It seems to me Scientific Management can get right on the job without waiting fifteen years.

Mr. Cooke: I was in an office in Philadelphia one day, and the proprietor was personally answering the telephone calls when some jobs were ready to be delivered. I tried to argue with him that that was not the highest function he could perform. He said he was not able to throw off all these things that he should. I told him each individual ought to use his highest faculties to the best advantage. When a proprietor spends his time answering the telephone and running out into another room to see if a job is finished or not, I think there is a chance for big improvement.

Mr. Browne: I was talking the other day with a man in a large printing plant (not in Philadelphia) who is a big man, a man who has gone through the routine of practical training and is looked upon as having a lot of common sense; he holds a big position. His statement to me was, "I am not big enough for my job; I am constantly doing things I have no business to do, but I can't seem to get away from doing them." This man is a thorough believer in routing, considers it as

absolutely the first essential to large printing orders, and yet he doesn't see his way to getting hold of the right application; even after he has worked it out in theory.

Mr. Cooke: It would be instructive to have each printer here in the room state what seems to him the principal handicap in applying these methods in his own shop?

Mr. Howe: In the printing office we have a general working system. We use the postal card system for our orders. Our customers insist on proofs, and we cannot tell when proofs are coming back because they never come back when they are promised. That makes it necessary for the foreman to plan the work over and over again during the day. The work of our office is very different from the Norwood Press, where they start in manufacturing a book and the work goes to one room after another. Scientific Management in our office would have to begin with the composing room. Somebody would have to take the copy and write on the margin all the different details, and then we would have to increase the number of foremen, or at least teachers, so as to put less responsibility on the compositor.

Mr. Cooke: You would have to come to making your copy instruction card absolutely complete. In regard to the proof coming back from customers, that, of course, is a very serious thing; but I think it is due in part to the attitude that "it is up to somebody else." We must do it ourselves and keep punching the customers.

A man told me that in his establishment in Philadelphia they found so much difficulty in getting certain firms to send in their work when they said they would, that he told them, "When you make a promise see that you live up to it." They have tried the experiment of having a high-priced man go to the telephone and call up a concern the day its work was promised, and say, "Yesterday you said such and such a thing would be delivered Thursday, the thirteenth. Is that promise still good?" They would say "Yes" and he would say "All right." The next day he would do the same thing. As a result they eliminated a good deal of delay. I believe we

shall see the time when, as we send out proofs we shall get a promise from the customer when he is going to send them back, and by means of the tickler we shall be able to follow him up. But this idea of outstanding proofs coming in tomorrow morning will not work, and I don't know how Scientific Management will bring it about. I think I should take my worst customers, and my most particular customers, and try to get into the habit of reminding them periodically.

Mr. Howe: What if the customers live out of town?

Mr. Cooke: I was manager in a publishing house and I had great respect for those printers who knew I was in arrears. Isn't that a psychological fact?

Mr. Smith: I am not able to judge what is the best thing to be done in the press-room.

Mr. Cooke: You mean trying to work out some scheme to better conditions? I think Mr. Howe's remarks very suggestive. What would you call the most difficult thing in the press-room problem to solve? There is no man in any better position to know than you.

Mr. Smith: I don't know that I can say. We have what is called systematic management. We aim to have the jobs very closely watched. We have a man who plans the work ahead so that there is no delay on the press, and no delay on the paper. I have no doubt that under Scientific Management, by a close study of the subject, there would be some gains in some ways. What those are, I don't know, as I haven't made a study of the subject. Our particular business is press-work. We have a large press-room. The economies gained in one room, multiplied by fifty would amount to considerable. I do not doubt but that there are some small savings we could gain, and we hope to some time, although I feel we have a good system today.

Mr. Cooke: I have been in your press-room and I know you have a fine system.

Mr. Howe: I understand there are some places where they use a cut overlay of paper and after taking an impression, they put it in a bath of acid. They claim that they cut down

the time considerably. A traveling man told me this week that in one office in Hartford they had increased their press capacity 30 per cent overlay cut out. Now there is no man allowed to cut so as to increase the product 30 per cent, I believe.

Mr. Browne: On flat work they use the straight cut overlay — they do use an overlay on the flat work — it is not the chalk lay.

Mr. Howe: I understand from our foreman that Berwick & Smith use it to some extent.

Mr. Browne: The thing, to one without a technical knowledge of it, may look in error. As an indication of what must come in printing is the development of the Mackay process used at the Curtis Publishing Company. The plate itself is made perfectly true so the question of "make-ready" is practically eliminated. As regards the process itself, it is not perfect yet, but does very good work. I have thought for a long time that something of that sort, perhaps part of the revolution of the printing-press, is a machine that will be of tremendous help, but will mean a tremendous change.

Mr. Cooke: The thing always offended me, — that when you put your type form on a plain surface, true it up to the foot of the type and put it on the press, you are not sure then of its being true. I should like to hear from Mr. Rowe who has had much experience in coming in contact with the outside printing shops, and who has obtained harmony between the outside and inside printing establishments. I should like to have him tell us, as he sees it, the ultimate future of Scientific Management.

Mr. Rowe: In my particular line of work of dealing with customers and the sales department on the one hand, and with the manufacturing in the bindery on the other, I can see a vast advantage gained through Scientific Management. Through the functionalizing of work of this character, the strain on the individual is relieved and the efficiency increases. The ultimate result *can* be nothing but enormously increased efficiency.

I begin to see where there is coming to me personally a relief from the strain caused by the overload of trying to perform too many functions.

The responsibility, however, on any one is correspondingly increased when he performs only one or a very few functions.

In answer to the question, "Does a person who works under Scientific Management become a machine?" I will say, I think he does in so far as he does work with the machine-like precision which increases his efficiency, so that he becomes a consistent part of the whole organization instead of a jumble of inefficient wheels working independently. That is the effect of Scientific Management, as far as it has been applied to my own work.

Mr. Browne: I think, of course, that with the placing of Scientific Management you cannot make demands on anybody of things he cannot do.

Mr. Rowe: In reference to that man in Philadelphia who said he could not throw off duties, it might be a good thing to have somebody sit down beside him, study his methods and tell him tactfully some of the things he needs to do. It is really one of the hardest things for most of us to do, to take criticism from anybody. We are not receptive in taking suggestions from outside. I think some of us in our plant have gained most in efficiency through this especial point in Scientific Management.

Mr. Smith: The foreman, being a capable man of experience, does too many things.

Mr. Cooke: The only way that I have found automatically to stop people from doing things they should not do is to state their duties in writing. When it is in writing, they seem to be willing to do things that they would not otherwise do, — if it is in writing they absolutely have to do it. Sometimes I wish there were no telephoning between departments. There are times when the more you can do in writing the better. It is a splendid check on unnecessary labor. We have made studies of people and have found that the clerks, especially,

spend most of their time walking back and forth. Day before yesterday, one of the girls in a certain office was going to send a telephone message to the floor below. I said to her, "Why don't you write a note about it?" So she did, — I think it took about ten or twelve words — and before I left her desk the answer to the note had come back.

Are there any further questions that anybody would like to ask?

MR. ROWE: We have been inquiring at our place concerning the best way to give an order.

MR. COOKE: I think that in the printing business, where there are so many details, it gets on our nerves very frequently. In giving instructions and in correcting people for having made mistakes, we sometimes put considerably more emphasis into what we say than is done in other lines of business. I have noticed that some establishments carry it so far that the people who are reproved for making errors are likely to make more errors as a result of the reproval than they had made before. The rule I have tried to use is not to get into conversations after four o'clock in the afternoon, because in a printing office after that hour the tension on everybody is very great. I find that, if I postpone my remarks until the next morning, the things that happened after four o'clock the day before seem to be trifles. From the standpoint of Scientific Management, if you can impress your employees with the fact that you are coöperating with them, the ones you have had to reprove in the past, as a general thing you will find, are less likely to fall down in the future. Unless you do coöperate with them the whole thing is off, because that is the spirit and substance of Scientific Management.

MR. MORRISON: In regard to the plants which have put in the cost system, of course the cost system shows a printer whether he makes any money on a certain job or not; it also shows the high price he has to put on a job to make any money on it; but in putting this high price on it he loses the work, for the printer who has not put in the cost system makes a lower price and gets the job. The other man loses the

business. Under Scientific Management would this condition be changed?

MR. COOKE: I think the industry is too big to be affected by that sort of thing. What you want is to do it 10 per cent cheaper than anybody else. Now in Scientific Management the gain comes from letting the other fellow do the work you are losing money on.

MR. DREIER: In the Forbes Lithograph Company do you plan all your work? Do you have a planning department? Can the men tell what type to use for the work before it goes to the printer?

MR. COOKE: We have not extended the planning part under Scientific Management to the point where that statement could be made, but a great deal of work connected with the printing industry is thoroughly planned. All the details of the routing of work, for instance, and planning for it, are carried out in certain parts of the industry with almost as much precision as is done in the Tabor Manufacturing Company.

I think ten years from now it will be possible to make instructions for composition so they will be very much more complete, so we shall have a pure style. Men are going to come into the business. It is not necessary to standardize the things we know are wrong themselves.

MR. MORRISON: Would you treat as three entirely different trades, composition, the press-room and the binding; or would you have one man plan for the whole three?

MR. COOKE: Absolutely alike. That to me goes with the foreman; that is what I consider the unfortunate feature: 90 per cent of the work in the press-room is exactly like 90 per cent in the bindery. You will see that if you analyze it. The machines are different, but if you analyze the machines you will find that they both need the use of an oil-can and so on; they are 90 per cent alike. What we are going to do is to emphasize the things that are alike in the different departments and stop the things that are different. The discipline is the same.

## V. PULP AND PAPER MANUFACTURE

LEADER, MINER CHIPMAN
*The Emerson Co., Consulting Engineers, New York*

MR. CHIPMAN: My experience in doing efficiency work in paper-mills has been limited, consisting of one contract only, and then only in a part of the work, the calendering and coating rooms; so when it comes to the practical application of the principles of Scientific Management to the pulp-mill I should not be at all familiar with that. I have thought that I would briefly outline at the beginning the chief problems which presented themselves to our company and to the men engaged upon the contract. We found first that the operations in a paper-mill were very similar to those in a flour-mill — in a way, largely mechanical — and that the number of employees involved was exceedingly limited. Secondly, we found that there were no records of definite standards. There had been maintained a great many records of the business in the past, but these pointed to no definite standards; so we had to develop in our own way methods for ascertaining them for calendering, in the chemical, mechanical and manual operations. Third, we found that chemical operations, something with which we were absolutely unfamiliar and incompetent to cope with, were exceedingly variable, and at that point it was necessary to call in the assistance of a man as special adviser from the chemical laboratory of the mill. Fourth, we found variations in chemical materials. Fifth, we found variations in stock requirements. Sixth, we found variations in the organization.

In almost the first conference with the management the superintendent said, "The first thing you will find, Mr. Chipman, is the deplorable idiosyncrasies of the paper business." I looked very wise. I had been used to it. In every other plant in which I had been, the manager would say, "Our business is just a little different from any other business

which I have been in." It took a year and nine months to demonstrate that pulp and paper was a little bit different from any other business, and if it had not been for the honest coöperation and assistance afforded by the appointment of competent men, and the open conversation and advice to my experts in the work, we should have been able to accomplish no results of any kind whatever. We wanted to start with the wood pulp, but they started us in with the coating and calendering. It was the least efficient part, but it was exceedingly difficult to begin with. We started the planning board and making the time-studies almost simultaneously.

In the operation of calendering, we spent three months and a half, following Mr. Taylor's method of time-studies as closely as possible, making the rough time-study and the analysis of time-studies. The operations in calendering are divided into five or six parts — I don't remember exactly what — high-speed, low-speed, make-ready, taking samples, mending breaks and a certain percentage for delays. We time-studied about 500 separate rolls, running through every grade and thickness. These data we analyzed, getting about 1,000 analyses of the time-studies, out of which grew schedules upon which we based our standard times, covering every grade and weight of paper, particularly book-paper, run through that department. We estimated that efficiency was about 52 per cent or 53 per cent. Upon the first week's operation it came out somewhere in that vicinity, — not more than 5 per cent variation, to our surprise. We expected, from past experience, that upon the application of bonus to those standards the efficiency would immediately come up and we would show a radical improvement in efficiency and attendant savings. Such was not the case. In all my experience I have never seen an efficiency curve rise so slowly or so uniformly as in that calendering department, although we offered 20 per cent bonus, with 1 per cent increase upon that. The reason was that they ran a good paper. In changing the grades of paper, they happened to run more machines and a gradual tendency towards increase of output appeared.

We found that the young men, the men who had been in the department the shortest time, took hold most rapidly. For instance, one man with a few months' experience ran up to 100 per cent efficiency almost immediately. Another man of two years' experience on an average over six months ran around 99 per cent. As soon as the management found certain men running at high efficiency and other men lagging at 50 per cent, they said, "These men are attaining that high per cent at the sacrifice of the paper." So the man in charge of the efficiency department made an exhaustive and intricate study of the waste problem and its effect upon the efficiency, and he proved that the run of lowest efficiency was making the most waste, and quite reasonably so. The man who would run through the greatest number of feet on the rolls wanted the least waste. He wanted the least time; he wanted his sheets as clean as possible running over those calenders. And in that line we were particularly gratified.

Our work passed into the coating room and back into the paper-machines. Then we jumped clear over into the cutting, sorting and finishing room. I want to make a final, general statement as to our figures. After we had made certain tests of various departments, we found we were up against a dependent sequence of operations. The paper-machines being the most costly equipment, the effort to secure efficiency was concentrated upon the paper-machines. They had a good product, had good discharge, and the percentage of the efficiency was high. It was reasonable to think that if the coating and calendering department was taking care of the paper, it was over-equipped 30 to 40 per cent. That is, if we attained to 100 per cent in coating and calendering, we would have to do away with 30 or 40 per cent of our equipment or increase the equipment of the paper-machines, and the question came up whether we could sell the paper. I saw, too, that if we brought up the efficiency of the coating and calendering we should have to increase the capacity of the cutting, sorting and finishing departments.

If I were to go there again, the first step would be concerned with the organization. I would bring every one, from the president of the company down to the last man in the laboratory, into the reorganization. The second thing; I would attempt to get my material through from the pulp-mill at a predetermined efficiency and to move along from department to department in such dependent sequence, that important changes in requirements of equipment would not come suddenly before the management.

As to particular questions or problems, any one is at liberty to ask questions upon points I may have suggested; or I should be glad if you would take them up among yourselves and discuss them.

Mr. Wolf: We started in at the Burgess Sulphite Fiber plant about five years ago to develop our business along scientific lines. At that time we had the reputation of making the worst pulp in the world. From making the worst pulp that was made in the world five years ago, we have developed a plant making the best. At any rate, we have increased the production from an average of 225 tons a day at that time to 350 tons, and in so doing we have been able to decrease the cost of manufacture.

We started in to make a pulp equal to the European pulp, and in casting around for a reason for the superiority of the European pulp, we found that in Europe they were employing technical men to solve their problems. Though Scientific Management, as we understand it and as we have heard it, has not been brought about there, they have studied their business from a scientific standpoint. They are employing only the best men as their superintendents and foremen. They lay particular stress upon technical training, and for that reason they have been able to make pulp such as we could not make in this country, because we haven't applied to the business the technical knowledge available. So we started along these lines. We increased our laboratory force from one man until we have seven chemists employed at the present time, — I mean seven graduate chemists. We have in

addition a lot of men collecting statistics connected with the laboratory force, making an organization considerably larger than any we know of with other companies. Some of these men are employed at investigation work, others are carrying out routine.

We began then to study the problems of management according to our lights. We had no knowledge of Scientific Management, but in a good many instances we were able to set our laboratory force investigating things chemical in their nature, things that had reference to reduction of labor cost and to the efficiency of the plant. We started a system of keeping track of the cost of handling raw materials per unit. For instance, in one department handling wood we have three men, one at each shift, and each of those three men keeps a labor slip which shows each day the cost of handling. That is put on his time-card the day following the day's work. On that card we have also his average for the month, as well as the average for each of the other two men, and also opposite that the average established on that particular grade of work. From that we get the efficiency.

When Mr. Taylor's and Mr. Emerson's articles first came out, we were very much interested. I went down to see Mr. Taylor and I got some very interesting points. We realized that we had just scratched the surface and that there was infinitely more to it. It is my firm conviction that in order to bring the paper business to the point of efficiency obtained in the old country, — I am speaking from the pulp end, but I know more or less about the paper end — we must employ technical men. Mr. Everard said that he was very much impressed during the trip he made through Germany, Norway and Sweden, with the fact that the men at the heads of the companies were paid very large salaries and that they selected the very best type of men they could get. I think the mistake is made here generally in not employing managers, — in employing superintendents. We hire a man and do not hold him responsible.

Mr. Chipman: Focusing the best technical knowledge

upon pulp manufacture is Scientific Management pure and simple, and particularly in paper-mills where there are such tremendous actions and reactions, — I can't give the chemical phraseology, but the effect of the variations of the chemicals upon the pulp and paper are so enormous as to far transcend the efficiency of a single workman or a whole department. The standardizing of them I consider one of the greatest moves in the paper industry, and I understand they have traced curves at the Berlin mills showing the product for a long period of time, which is admirable.

Mr. Wolf: We have found that this thing pays. We have not spent one single dollar that we have not got back in less than a month's time, and in other companies they have more than paid in less than a year's time. I say this because a great many investigations take over a year before one can draw conclusions. The thing pays and it pays greatly, in proportion to the amount of money invested. You can't afford to do without it.

Mr. Whitney: I should like to ask Mr. Wolf if in their scientific department they adopted the bonus system in any way.

Mr. Wolf: We haven't gone into that at all. The piece-work system has never been used in the paper-mills, and we feel that that is a thing that we should have to go very cautiously about. Whether it is at all wise to establish a piece-work system or not is a question. We do believe that men should be compensated for the work that they do, and that it pays to employ good men. That is a thing we are studying very carefully. It would be most ill-advised to start in and upset the rate of wages before you have made careful study and taken into consideration the effect it may have upon the rest of the plant. The thing never has been done in a paper-mill. It is a revolution. The thing has to work in through the organization first. Make some changes, get interested in it. As Mr. Taylor puts it, collect the primitive knowledge the men have first and improve upon it, study and apply it. From the inertia and antagonism that exist in a paper-

mill towards anything new, we have worked up a spirit of coöperation there, so that the men are more disappointed if there is any failure than we are. For that reason we are very careful not to make any false moves and make sure that we are going to make successes. Each success makes the men more confident in the management. It gives them a feeling of pride in the organization.

Mr. Whitney: I appreciate the fact that it is a very difficult thing to establish a reward or a bonus. At least I haven't been able to do it as yet; but so much stress has been laid upon that point that I should like to hear, if anybody has anything to say on that subject, how one would apply that sort of thing to paper-making.

Mr. Chipman: In the particular plant where we applied the bonus to 500 or 600 men, we had no complaint between the various departments as to the bonus that was earned by any department. We maintained the rate of wages current in the mill. That has to be guaranteed under any bonus system which is equitable, and upon that we paid a bonus in proportion to the efficiency. If the entire average of your departments were equal, your rate of wages would be the same, but if you should suddenly develop a man at 100 or 150 per cent beside a man of 40 or 50 per cent, there would be considerable variation. Then it becomes a question whether you are putting in a premature bonus or not. I am coming more and more to be of the opinion that a bonus should be the last thing to be introduced into your plant. Your conditions should be standardized, your organization perfected, before ever thinking of adopting one cent of bonus. I think at a great many plants the bonus has been put in before they really had an exact standard, and a higher bonus was established than was necessary.

Mr. Whitney: I should like to make this inquiry in connection with the statements you have just made: did you in the course of your work in that particular mill, establish individual efficiency records or did you establish room records, or gang records, or establish the unit working hours?

Mr. Chipman: The only way we could pay a bonus was to get the efficiency on each individual operation. Averages mean nothing. You cannot take even pretty stiff averages in a paper-mill and pay a bonus. We had the record of each individual operation of the work. We maintained the record of the efficiency of a particular man on all the grades of paper that he ran on a certain machine, totaling the standard time he developed and the actual time he consumed, and the ratio gave him an average efficiency covering the total period. The bonus was paid on that efficiency. We maintained an individual efficiency record for every workman on every machine. If the foreman of a department wanted to know what any particular man was doing he could turn immediately to the records and they would show what that man had done for any time, — any day or week, or his average. Those records could have been maintained irrespective of any bonus system.

Question: I am not a paper man but I have been through a paper-mill, — walked through — and I should like to know how it is possible to get individual records in a room such as that in which the big paper-machines are, where five or six operators are on one machine and no one of them, so far as I can see, could be made responsible for any particular product.

Mr. Chipman: You have stated an exception right off. That would be the same as Mr. Taylor's gang system. We include that big operation as a whole. It then becomes the efficiency of the gang.

Question: If you should attempt to establish a bonus, it would be for gang efficiency?

Mr. Chipman: Yes. For instance, in gang work — not in paper-mill work — a very interesting thing once came up. In Pittsburg, on a particularly large contract, we established a certain wage for the gang, not an individual workman's wage. We set $10 a day for the gang; five men in the gang, $2 apiece. If four men could do that work they would still get the $10, so added to the bonus was the impetus for selection among those men and they would want

to reduce their crew to the lowest possible number of men. The result was that in that particular crew in a large boiler shop, in the course of the work they reduced their crews from eight to five, turned out the same amount of work and got the same wages as the former crew of eight.

QUESTION: Where did the other men go?

MR. CHIPMAN: When you ask me where the other men went, you then come to another interesting problem. In one plant we were laboring strenuously trying to reduce the pay-roll in a certain department. They asked what results we were getting and we said, "We have reduced that pay-roll 20 per cent." The manager said, "I don't see that you have, the total pay-roll is just the same." We found the fellows who had been removed from the first department were in another department. We got them out of there and we still found that the pay-roll was not coming down. So we went through the whole plant, and we finally found those fellows out in the yard doing yard work, and it was not until we had absolutely finished the plant and walked out the back door that we knew what had become of them.

MR. MOORE: What would you do if you were in a town where the whole population is inefficient. You cannot fire your labor. They get their pay and then take two or three days off.

MR. CHIPMAN: Your question is a very good one. We divide plants into two divisions, — one which the efficiency engineer or betterment engineer can work upon; the other which requires the services of a surgeon. If a man has a paper-mill and there is a railroad through the town and a river flowing there, if that river suddenly changes its course and the railroad ceases to run, I should think the paper-mill in a bad state; but it is not a job for the efficiency engineer, it is a job for the mover. When it comes to a paper-mill in a town where a lot of families are growing up and the manager marries the sister of the wife of the mill-owner, or the foreman of the finishing department marries the daughter of the superintendent of the stock-room, I should say, handle the

Scientific Management step mighty carefully. I have been there.

Mr. Wolf: Have you ever applied any tests to the paper-machine end?

Mr. Chipman: The paper-machine end was taken up by the man who superseded me in charge of the department. In our opinion he did most admirable work. We found the ordinary time-study applied only to the most limited degree. It covered practically only the delays in the matter of changing the width and putting on a new felt. The repairing and new parts of machines we could time-study, but when we came to the actual making of the paper, if we were to stand with a stop-watch what were we going to write down? So the gentleman in charge of that work made a minute study, covering a long period of years, of the achievement of the paper-machines upon every grade and weight, until he had plotted a curve of the achievement of each machine from a very low weight to a very heavy weight and he got some beautiful curves. It is a matter of long time; it is a matter of variations, and the mere matter of a stop-watch time-study would be rather futile.

Mr. Wolf: Have you made time-studies to standardize the beaters?

Mr. Chipman: We never timed them; we didn't like the looks of them. The man in charge of the beaters said he could reach down into the machine and in that way tell exactly what its condition was, and after a little investigation I found that that was literally true. Mr. Greene had spent a number of hours making lantern-slides of various stages of the beater work, and after he got through with all that, this old fellow could stick his hand down into the machine and tell him more about it than all his slides could prove.

Mr. Wolf: I found the thing worked out very successfully in a mill I was in a few days ago.

Mr. Chipman: I understand that they have worked it out at some plants, but as far as I was concerned I let the beater proposition alone.

Mr. Wolf: I will not say where I saw this, but I saw a beater-roll which was worked by means of hydraulic pressure, whereby certain pressure could be put on the bed-plate and for certain grades of stock they had an absolute schedule of just how many pounds of pressure should be used. They had a very good thing. It struck me as about the only solution of the beater problem. It will be put on the market very shortly. It is working and very successfully.

Mr. Moore: I do not think there is any business that has quite so many variables as the paper business. In the first place, you have the variation in the wood, the same kind of wood grown in different localities; in the second place, you have variation in time of year the wood is cut; third, you have variation in the time it is stored before use; fourth, you have variation in your chipping, which may be considerable; fifth, you have the chemical variations; and those chemical variations, which I shall not go into minutely, can be classed under the variations of acid, that is to say, the bases, the proportions of your bases and the kind of bases in use, the proportion of your acid radical and, more or less, the kind of acid radical; then the cooking, the variations of temperatures and a whole lot of secondary reactions which take place due to the variation in temperatures. In fact, one variable affects another variable so much that it is impossible to tell where one variable begins and where the other one ends, or whether it is due to this variable or to something entirely overlooked. Then after that you have several other variables, such as the effect of washing with hot or cold water and different things of that sort. I might go right through the whole list, even down to drying. You say, "There is no variation in drying," but as a matter of fact you are changing a certain amount of pulp into sugar, and from the start to the finish in making a pulp you have chemical variations that can be told only by the result of the tests. You see the finished product, but you don't see the process as you do in a lathe. There is no chance for chemical measurement of the variables.

Mr. Wolf: I have every confidence that if the paper and pulp manufacturers of this country should apply the technical knowledge we have, we should beat the world. I think that applies to any industry. I don't think that is "spread-eagleism."

Mr. Mulliken: Going back to the original speech of Mr. Wolf, in which he told what good work the Burgess Sulphite Fiber Company has done, I should like to ask Mr. Wolf about the time-studies which increased the output of his mill from 225 to 350 tons. Is that right?

Mr. Wolf: I want to correct that impression. That was not due to time-studies, but wholly to the quality of the pulp which the paper-makers were using.

Mr. Mulliken: I will vary my question a little bit. You did get some increase from time-studies?

Mr. Wolf: Oh, yes; we did.

Mr. Mulliken: Were the men rewarded in any way?

Mr. Wolf: I think I answered that question originally. We have made no change in our method of paying the men.

Mr. Mulliken: And they were quite willing to abide by the time-studies?

Mr. Wolf: The men did not know any time-studies were being made. We made them in such a way that they didn't know anything about it.

Mr. Mulliken: Do you know any paper-mill that has adopted Scientific Management?

Mr. Wolf: I know one paper-mill that is now in process of adopting it. I am not at liberty to name the mill, but it is under Mr. Taylor's management. I talked with the manager and he is very enthusiastic and sees possibilities that he had never dreamed of.

Question: Can you tell us what grades of paper they make?

Mr. Wolf: Book paper, fine paper.

Question: Coated?

Mr. Wolf: Yes. Don't ask any further questions for I can't say any more. They make very fine papers, I will say that.

Mr. Whitney: Would not your judgment be, Mr. Wolf, that the only really good way to introduce Scientific Management is to get a very competent man who has been through that sort of thing in some other industry, who could bring to that business the knowledge he has gained through other business in that work, rather than to get the man who is trying to manage the men and do it himself?

Mr. Wolf: I think that is a very desirable thing to do, to get a good man to come in and start you right.

Mr. Whitney: It seems to me that going wrong at the very start would be fatal to success.

Mr. Wolf: Yes. We started using cooking records. We plotted graphically the process of cooking and plotted the gas pressure, which is the pressure computed from the temperature. We subtract the gas pressure from what we call the steam pressure and obtain the actual pressure. If that drops too rapidly, it shows the digester is being relieved too hard. We started in to use those records and we almost had a strike. The men would not use them; they said they could not be taught to see with a lead pencil, but they finally took it on trial. By handling them very carefully and getting their good will, they fell in with the idea, and you could not take it away from them today. I was showing one of our men these cooking records and I said, "I am going to show you something," and I hauled out some old mill records. He said, "Did we ever cook like that?" I said, "You certainly did." He said, "It makes a fellow feel the same as looking at a picture of himself when he was drunk, after he had sobered up." That was the change in their attitude towards these things. Our men will now take anything of that kind. It had taken five years to bring that about, and we have had to go at it very carefully and cautiously and we sometimes got near the danger line. Now there is no danger at all. We can try any innovation we want.

Mr. Moore: The charting of your results in a paper-mill is about the only method I know of arriving at what you are doing. The first time that struck me was in the year 1899.

Mr. Barton, head of our chemical-mill (I helped him, but I think his was the original idea), charted some efficiency curves, showing what governed the efficiency of service. We discovered a very remarkable law — what the law is I am not stating at this meeting. Suffice to say, that mill has been running according to that law ever since. The only way the effect of one variable upon another can be shown is to draw some major line and the effect of these variables upon this major line must be charted. You can plot results and work backwards so as to see what is happening, and that is the only way you can work in the paper industry, where you have such complex problems.

Mr. Whitney: I had an interesting experience in connection with our ground-wood mill. It is a very small mill. The power from year to year is quite variable, depending upon meteorological conditions. We found that when the power was less we were making proportionately more pulp. That was done simply by a curve; we plotted the results of what we should get under the power, assuming certain conditions, and then we plotted what we did get. These two curves were very close together at the lower extremity where the power was less, and as we went up nearer the full capacity of the mill the actual production fell off very materially from the theoretical curve. Then the thing to do was to look about and see what the difficulty was. This brought out the fact in our case that when we were suffering from low water we were grinding at very low pressure and reasonably sharp stone, as sharp as we could get without making inferior pulp. Then we set about to keep these conditions uniform through any amount of power we might be having up to the capacity of the mill. Instead of changing the pressure on one grinder as the amount of power increased, we simply put on another grinder; not increasing the pressure any more, but keeping that constant and increasing the amount of wood put on the stone. Unfortunately, after adopting the system there has been no increase in the power itself. For three years we have had very low water so we haven't been able to

see how our actual production curve compares with the theoretical one, but as far as we have data, it looks as if the two would coincide. It shows the value of putting these things into graphic form, for that point might be easily overlooked in a mass of figures.

MR. WOLF: Did you determine the best pressure per square inch?

MR. WHITNEY: No, we haven't got so far as that, but we determined that on our sixteen-inch rolls a pressure of twenty-five pounds per square inch was ample.

MR. WOLF: I mean on the surface of wood exposed?

MR. WHITNEY: That of course would have to be multiplied by the power per cylinder and divided by the square inches of the stone. I haven't done that.

MR. MOORE: The graphic methods are the only methods you can use with any degree of success in showing results, in a paper-mill especially; and it would pay any mill to put in a room for the purpose of taking the information and plotting it graphically and handling the statistics.

MR WHITNEY: I am doing that as fast as I can.

MR. MOORE: In the graphic system you stumble onto laws that you didn't think existed. That is very interesting.

QUESTION: Mr. Wolf, what experience have you had along the line of handling materials, storage of pulp and paper?

MR. WOLF: You mean in the storehouse? We have had so many other things we have neglected it. We are starting now to put in a thorough system of storehouse operation. I have been through the Watertown Arsenal and the Tabor shops and one other place where I have seen it in operation. It is a splendid thing. It enables you to reduce your stock on hand to the minimum and never be in danger of running out.

QUESTION: I should think it would be one of your biggest auxiliaries, you have such a large plant.

MR. WOLF: Our main supply is wood. We keep anywhere from $500,000 to $1,000,000 worth of wood on hand. We have usually not far from $750,000 worth in the Burgess

mill alone. That of course you cannot regulate by any particular system. You have to govern yourself by the market conditions; you must buy when you can and store it. We carry about $190,000 worth of mill supplies and, of course, as the mill is large and doing a good deal of work, we need a large supply, but this is too large, and we figure that we can cut it down a great deal. I don't see a single thing about the paper business, even down to the operation of the machines, that can't be worked out on an absolutely scientific basis. We have standardized things that we had no conception when we started we could standardize, any more than we could standardize the blacking of a pair of shoes, yet we have succeeded and are getting surprising results. I don't think these paper problems can resist the pressure brought to bear upon them any more than any other business can.

Mr. Whitney: I think you strike very much greater prejudices in the paper industry. I don't know of any more prejudiced people than those in the paper-mills.

Mr. Wolf: Absolutely the worst. I don't mean to hurt any one's feelings. I mean the old fellow who has worked along in the old way. When I started in to learn the business, I had to keep almighty quiet the fact that I was a college man. The idea of a college man wanting to learn the paper business was preposterous to them.

Mr. Lincoln: I think the problem the paper men are coming to find, is not so much the making of paper as the maintenance of machines, keeping them in condition and having them work perfectly, and not having them run with a little jerk here and a jump there. When you go down the line you find perhaps a machine is bucking and things of that sort, yet you wonder why the paper doesn't come uniform. You go into the grinder-room and you find they have the roll lower on one side than on the other, and you expect the men to make a fine roll of paper. The difficulty is with the organization, in not looking after things of that sort, in allowing them to occur.

Mr. Whitney: So many things can happen. I remember our mill was making "broken" fir three days and we could not discover the cause. Somebody was bright enough to chart the clutch, — an old-fashioned cup clutch. He drew a line across the two parts of the clutch and after a while, — after the next break — looked at the chart line and found that had pulled off, showing that it had been slipping. Just that had made all the difference. We had lost practically the whole product for two or three days because that clutch was slipping.

Mr. Lincoln: I should like to inquire whether the gentleman who asked about stores has any information to give us.

Mr. Camp: I haven't; I was trying to find out what the other fellow knew.

Mr. Wolf: The best places to get that are the Watertown Arsenal or the Tabor Manufacturing Company of Philadelphia. At both of these places the management will be glad to show you what they have.

Mr. Moore: I have been to both. They are very similar. Watertown is the newest and the letters on the storeroom are more suggestive of the article you wish to find.

Mr. Camp: I have only one question, — about the double-bin system. At Watertown they went into it very liberally. There they are free from competition and they have the double-bin arrangement, taking a great deal of space which in some manufacturing plants is expensive.

Mr. Wolf: In order to give the Government certain information they want, they have to put in a lot of unnecessary stuff that would not ordinarily enter into the case. You will see a more simplified system at the Tabor shops.

Mr. Moore: In keeping supplies of such petty fittings as elbows, tees, screws and everything of that kind, — things that are used in large quantities, — you can't know, if they are in one large box, how many you have. You are using a thousand quarter-inch bits a day; you are not buying those every day, and if you have the double-bin arrangement it is a warning when you have used one that the storekeeper should get busy and order some more.

## VI. LUMBERING AND THE MANAGEMENT OF TIMBER PROPERTIES

Leader, W. R. BROWN
*Berlin Mills Co., Berlin, N. H.*

MR. BROWN: I think it is safe to say that we are here primarily for the purpose of gathering new ideas for securing an immediate or ultimate economy in our line of business. With this in view it gives me pleasure to present to you a partial scheme of management we have worked out, which, though far from complete, may suggest some new ideas to you in your several lines.

I will take up forestry first, it being both an integral part of a properly conducted industry and of importance also to the larger interests of state and country.

Given a tract of untouched timber-land to start with, the first duty is to secure an expert and determine its condition as to growth and value and prearrange a plan for its care, in order that the owner, either private or public, may reap the greatest benefit therefrom. The forester will explore it to report on the kind and amount of lumber, its condition of growth, what shall be taken, what left, etc. He will survey and map it carefully to present this information in a concise way, usually by means of contour-line maps, painted or ruled to show species. He will make a plan to protect the land in the future from decay and wind-throw by judicious cuttings; from insect depredations; and from fire risk by the establishment of watchmen on the tops of mountains, the use of patrols, the building of trails and telephones, installing fire-fighting apparatus at needed points; and in a broader way by coöperating with his neighbors and the state along these lines.

I will say that within the last year the timber-land owners of New Hampshire have coöperated with the state both in a financial way and in the way of putting on men, and that we now also have the coöperation of the Federal government,

and the system is worked out in the best possible way for all people concerned.

The forester will finally determine the rate of growth which may be gained by judicious planting or cutting, together with the acreage, and report on the continuous supply of timber which may be expected from the area, to help run the industry and to serve the state.

After the forester comes the forest engineer, who works out the cheapest and most efficient manner of building roads, cutting timber, driving streams, railroading, and using modern instruments such as steam, dynamite, and telephones. As an instance of this, I cite the improved driving of streams, which used to be done in a more or less haphazard manner.

Then comes the district manager, who creates a staff of helpers to carry out the work; he contracts part of it to jobbers, purchases or sells, audits reports and accounting, and is the head of the operating.

He calls to his assistance in the staff an inspector, who saves waste in cutting, and reports weekly on special blanks; a head scaler, who corrects mistakes in scaling and marking; a telephone man to keep up the means of communication; a cost accountant, who saves waste by installing a minute but simple set of camp and storehouse books, and figures out and returns prompt and reliable data on every operation. I have here a camp book and some other data which it might be interesting for you to examine after the meeting. He employs a machinery expert who sets up and looks after the logging engines, the steam towboats and log haulers; a traffic manager, who prearranges for the securing of good car service from the railroads; a purchasing agent, who saves by combining orders, watching markets, and obtaining discounts; a veterinary, who saves by taking charge of the horses; and a statistician, who gathers and tabulates information in a logical way for guidance in the future.

Each of these concentrates on some detail and in the end saves more than his cost, and all by coöperation form an effective working body.

In the direction and organization of this staff, I wish to present to you a system as shown by this chart which we have worked out on the side of the management wholly. The labor side of Scientific Management which calls for task-setting and a bonus we have not taken up as yet, because we are uncertain about its advantages. Whether there is any analogy between the shop and the camp in the woods is a question. Whether the elements of routine, immobility, continuity of service and steadiness of life which characterize the shop man and enable the shop manager to train him to a fine point, are not all lacking in the timber jack, is a question. The jack is constantly meeting emergencies, is isolated and therefore hard to watch or guide, is dependent in his work on weather conditions and is commonly a floating, irresponsible character. In a certain way, we approximate the bonus system by determining the amount of pay at the close of a season, or operation, by the individual ability and energy shown by each man, as it appears to the boss; and the boss, in turn, is rewarded by the district manager. For this reason, they are not so likely to go slow. I doubt whether it is always best to set wages by the result of processes, or whether tangible results always represent the true value received from service. The human and psychological side often plays strange pranks with logic, and justice should be tempered with mercy.

This chart for organizing and instructing the staff is based on three lines of thought, which follow each other in natural sequence in considering any enterprise:

*First,* forming a plan of what is to be done.

*Second,* keeping the records of the carrying out of that plan.

*Third,* keeping the experience and data gathered from it. These, with imagination, usually lead to the forming of another plan.

We have called these the Budget, the Accounting and the Statistic. A book is kept for each which contains a skeleton outline of the data in every department and every operation, for the advice and guidance of the general manager

and those of his staff who are particularly interested in any department or operation. The staff consists of district managers, accountants, forester, inspectors, scalers, engineers, electricians, traffic manager, purchasing agents, and statisticians.

The first of the three books is the Budget. It is routed down through the staff at certain times and seasons for their suggestions thereon, and should tend to a consensus of judgment of all those particularly interested in work which is to be undertaken. The second, the Accounting book, and the third, the Statistic book, are kept in the general office, and necessary reports and extracts from them are sent out to the members of the staff by the statistician, whenever needed.

The object of the Budget is to reduce loose plans or opinions to a scientific basis, and will result in saving due to the adjustments perfected between different parts of the business; the drawing together of the staff in united effort, creating *esprit de corps*.

The accounting system should gather absolutely accurate, far-reaching and prompt reports, so that the general manager can have at least once a month the cost of every detail, however small.

Statistics should be gathered at all times, and all reports and records should be filed away and condensed so as to be easy of access.

In working out a skeleton plan of departments and corporations under three heads, we have separated for convenience different districts, and under each district we have divided the work into logging, driving, and the purchase of wood. Under logging, after making out a general plan, we have specifically named forestry, which divides itself into the cutting method to be pursued; inspection of cutting and scale; protection of woodland from fire; wind throw or insect kill; estimating; surveying and mapping. Also under logging we have named the establishment of storehouses; the establishment of camps — both company and jobbers'; the building of railroads and their operation; the purchase and care of

horses; construction of telephone lines; insurance of buildings and other property; the sale of stumpage; rents and leases, and carrying on of farms and payment of taxes.

Under driving, after making out a general plan, we have named specific drives; storehouses as serving drives; the carrying on of driving corporations; the making of stream improvements; the engineering problems concerning tow-boats and launches.

Under the purchase of wood, after making out a general plan, we have specified the requirements of mills; the sources of railroad supply; instructions to purchasing agents; traffic requirements; the handling of plants required; and offices maintained.

A general formula carries suggestions for answers under all of the headings above in every budget as to, first, place; second, time; third, amount and kind; fourth, labor; fifth, equipment; sixth, measurement; seventh, conditions; eighth, price and payment; ninth, accessories; tenth, accounting and costs. By changing these a little to suit the different kinds of business, they seem to cover the ground and give the suggestions which will allow the particular staff officer to answer questions in his department.

In the accounting division complete records are kept to correspond with the various operations named above, simple as possible for the man in the field, and in the nature of records to be sent to the main office to be combined into a double-entry system.

In the statistical division data are collected as fast as possible under the heads of the operations named.

The above general plan has been made to suit the particular needs of our business, and should be modified and added to in many ways to meet other conditions. We are glad to present for your consideration any suggestions it may contain.

I will call on Mr. Witherell, who has been in Scientific Management work in the South, to tell us a little of his experience there.

Mr. Witherell: As far as I know I am one of the first men, with training along what might be called industrial engineering lines, to go into the lumber business. Although I came from Massachusetts, almost all of my work has been in the southern states, in connection with several of the larger operations in the long-leaf yellow pine district. I have not taken up to any great extent the accounting end of the woods and mill operations.

One of the larger plants, at which I stayed for some time, worked twelve months in the year, as is the custom in the South, keeping the woods and mill operations going simultaneously. In fact, everybody in that region felt that it was a crime to shut a mill down for even fifteen minutes, and I believe this mill had not shut down more than a day in three or four years.

I took up the problems of improving the efficiency of the woods operations along the following lines: sawing, skidding, track-laying, grading and transportation to the mill.

When I came to this plant, I found, somewhat to my surprise, that three-fourths of the men were negroes. Very few whites in the South are efficient as working-men, except possibly as sawyers. However, the negroes make good workmen when well trained.

I found that most of the trees were cut off so that the stumps were from twenty to thirty-six inches above the ground. The men were paid on the piece-rate basis, thirty-five cents per M, and would not cut any lower, as a general average, than between twenty to thirty-six inches above the ground. We noticed that 75 per cent of the stumps, which had an average diameter of twenty inches, were almost a clear sap grade, which would sell in foreign markets for from $25 to $40 per M. Such a stump is full of pitch and is very hard to cut down, due to the gumming of the saw. We tried various experiments, using a stop-watch to find out how long it took to cut down respectively a long-leaf and a short-leaf pine tree. We found that by leaving a ten-inch or twelve-inch stump, we could get about 80 per

cent as much work out of the men as by leaving a thirty-inch stump.

In order to make it worth while for the men, we raised the price to forty-five cents per M, and required them to leave an average stump height of not more than ten inches. We had about fifty crews of men, the average crew not working more than seven hours a day. Occasionally the men would work eight hours, but usually six or seven hours of hard work would use up a man's energy, and the men would rest the remainder of the time. We found that the men could not do more work, but that they would cut the trees lower if we compensated them for it. We took an additional cent per M, and made it into premiums, giving a premium of $25 per month to the best crew, to the next $20 per month, to the next best $10, the next $5; that is, the men leaving the lowest stumps, the men who were really doing the best work for the company, received the premiums. The best crews averaged between fifty and fifty-five cents per M, the premiums actually making a difference of from twelve to fifteen cents per M. Meanwhile, the company was getting from one to two feet of the tree that could be cut up and sold for $30 to $35 per M. I do not remember just now how much the company got out of it, but I think the ratio was about two or three to one, and everybody was satisfied. Much to my surprise, some of the best men tried to cut trees a few inches from the ground, because they were so anxious to receive that additional $25 per month. We usually found that the whites were better sawyers than the negroes. In this plant the company furnished two and four-cutter saws, and we obtained very good results.

With regard to skidding, the company, only about a year before I came, used the old methods, that is, drawing the logs to the track by oxen and mules. Shortly before I came they bought a skidder, something like a Clyde, but even more effective. There were two separate cars; the front car being an "A" frame with four pulleys on the top. As soon as this car was set up, it was braced at four points with ropes

which were carried out about 200 to 300 feet and fastened to stumps or trees. On another car were two double-drum hoisting engines, each about 40 horse-power, and a 100 horse-power boiler. Behind this car was the fuel car with wood and water. This expensive layout, costing about $10,000, required a fireman, tallyman, water-boy, four engineers and four crews. There were four steel ropes, each covering a separate area and needing three men to operate. This machine was quite efficient, and would rapidly handle the logs near the track. The maximum rate of speed of the machine for short intervals was between 2,000 and 3,000 logs per week, and was obtained by getting the men to work together and not waste time. In bad country, the skidder would often not get in more than 1,000 logs a week.

Question: Did you have to build a railroad?

Mr. Witherell: It was not much of a railroad, just enough so that the cars would stay on the track. We laid out the tracks from 1,000 to 2,000 feet apart; we tried to keep the skidding distance not more than 600 feet.

We studied the skidder pretty carefully, and determined that if the men were properly trained they ought to be able to raise the average rate from 500 to 750 logs per day. We called 750 logs per day 100 per cent efficiency; and the whole skidder crew would get no bonus at 550 and at half-way, or 625 logs per day, a bonus of 10 per cent. The great losses of time seemed to be in the lack of coördination. The men putting the chain or hooks on the log would not be careful in their work and the chain might slip off, or they might put the cable at about the center of a log (causing a tie-up among trees). The boy driving the mule very often would waste 25 per cent to 30 per cent of the time. He might be off the mule and not attending to business. We made the mule-boys try to keep not more than 100 feet away from the log and try to get to the skidder as soon as the men took the chain off the log. Then the mule would be ready to take the clamps and rope back. We found it very easy, by watching various movements and timing them, to save from 20 per

cent to 30 per cent of the time right at the start. As I remember, gang on line one was against gang on line two, and gang on three against gang on four. We divided up $5 a week to the gang of three men which had done the best work; not on a weekly basis, but on a monthly basis, thus making it worth while for the men to keep at work steadily in order to regularly receive the extra compensation.

Later on, we found that these large machines were quite expensive and were exceedingly hard to move. They were not economical with a twenty-man crew when we got into a swamp. So a small skidder on skids was constructed that could be used in swampy country. We could take the whole machine — consisting of a boiler and two line drums — load it on a flat car, skid it to the ground and place it by mules where we desired. In some parts of the country wheels were not of any value, any more than in the swamps of Louisiana and Mississippi, where most of the country is under water a good part of the year.

In taking up the loading we had another interesting problem. The men who did this work were very different in temperament and ability. The man in charge of the loader seemed to have the hardest work in the woods operation. In handling his loading machine, the loader would have under him a top loader on the car, another man hooking the logs, and the engineer and fireman on the locomotive. The average log car held about twenty logs. The usual scheme of operating had been to let the boss loader load a certain number of cars a day. After study we decided, however, that something could be saved on this operation. When one of the loaders left the company's employ, we started out with the other two loading crews. We told them that a loading crew cost $10 a day. We said, "If the two crews can do as much as three by attending to business, we will split up between the two $5 a day." On some days we had to get out the third loader, and load a few cars back in the woods, but the woods operations got on pretty well with two loaders working about twenty days in the month.

Next we took up track building. We had with us a man who had been with the Southern Railway for years, and his rail-laying average had been about six rails per man per day with a twenty-man crew and a train. Six rails per man was the past year's record. We studied his work very carefully and were surprised to find out how much time he lost. He would frequently lose anywhere from thirty seconds to a minute per rail by not having the rail car in shape. Eight men laid four rails, then six spiked down while the rest of the crew were carrying the ties forward. We had a man stay at the rail car who had nothing to do but get the rails ready. It saved regularly about thirty seconds to a rail. The form of procedure was to put down about five rails, the men walking back and forth five times, and then spike down. We could not improve this operation very much, but we did get the men in the habit of taking a rail off the car, dropping it and coming right back. In putting the rail in place, we often found we lost thirty seconds to a minute on account of tight bolts. Once in a while the rail would slip in all right; if it didn't there was a minute's delay. We overcame this trouble by loosening the bolts before the rails were slid in place. We also found we lost time on the ties in laying on the grade; also in keeping the men driving spikes up to maximum efficiency. We actually increased the output from six to about eleven rails per man per day in about three weeks. Later a better rail car was designed. As soon as it gets in service, I expect them to come up to about twelve rails per man per day. Though the men did not work as hard as before, the work went along nearly twice as fast. We gave the men a bonus of 20 per cent if they got up to ten and a half rails per man per day, and nothing at about seven. The foreman was so interested that he bought a stop-watch, and watched his crew closely; so far as I know, he has been able to keep up this rate. We have increased in about the same proportion the taking up of track, taking up about eleven rails per man per day by close organization and coöperation.

In the transportation of logs to the mill the crews were

working pretty efficiently and we did not put them on the bonus. As soon as we got the logs into the mill they were taken up to the saws. One of the first points we noticed was that the saws were changed twice a day, each saw running five hours. We had them changed five times a day and got much better results. The sawyers were working very efficiently in that plant, and we were afraid if we put them on a bonus they would try to speed up and lower the quality of the lumber; so we did not give them a bonus but raised their wages slightly to compensate.

I found about twenty-five or thirty men, as I remember, on the sorting platform, sorting into fifteen or twenty grades. More than half of these grades went to foreign ports. The men sorting were very inefficient, and we found that we could cut them down to about eighteen. By paying them a slight bonus we got pretty good results.

The transportation problem was not a very bad one, but they had a flexible system, with two-wheel bogies, which could not be greatly improved. We found that they worked the horses and mules about to the limit. We found also that they loaded with about 200 to 400 feet, while some of the bogies had a capacity of about 1,000 feet. At any rate, we loaded the bogies up to about what they could stand and we were obliged, as I remember, to dispense with something like one-third of our teams.

In carrying the lumber to the kilns we had six kilns and five crews. As I remember, the cars going through the kilns carried about 4,000 feet. The men had their schedule of some six cars a day. We put them on a rate of eight with a bonus of 20 per cent. They came up to this rate and one crew was laid off.

We tried the same thing in unloading the kiln cars and found it worked well. The men were not working anywhere near to their full efficiency, and if they wanted to take a few hours off they would hustle. The average rate was about six cars per two-man crew per day. We made a standard of about nine cars with a 20 per cent bonus, and the men

got after it. It may surprise you to know that negroes will go after a bonus. Most of these men of whom I am speaking are white; they worked more intelligently than negroes.

In the planing-mill we found a good many machines of the older types. A good many were running at the rate of 50, 75 and 100 feet per minute. We found the slow rate at which the material went through the planers was due to the way the men were running the machines. We increased our machines up to all they could stand, and that company will put in new machines which will run at the rate of 175 feet per minute.

In the loading of the cars for final shipment, we found that the men worked in the same way they worked in the other departments, that is, only about half a day, at a slow rate. I do not remember now about the average rate, but we increased it about 40 per cent, and gave the men about 20 per cent more money as a bonus.

There was a saving in the cost of operations all along the line, a few cents in each operation; and, as I remember, the total saving amounted to something like fifty cents per M. in the woods and mill. This is not a large amount, but the plant is probably one of the best-operated properties in the South. The plant was not what would be termed modern, but was making money and had a regular output.

Mr. Brown: We have with us Mr. Bryant, who has charge of the Lumbering Department at Yale, and I think we should all be very glad if he would talk to us for a few minutes.

Mr. Bryant: I came to learn something and not to talk. In fact, I don't know so much about your eastern plants as I do about the southern. Mr. Witherell's talk was very interesting to me. It seems to me that where an improvement can be made in our logging operations, very frequently is in planning operations ahead. In some parts of the South, especially in the rough regions, it would be well if the manager would have a topographical map of his property to show what most of his woodsmen have ahead of them. When these men leave you, you have nothing to say to them

afterwards, and sometimes they have several years' work to do. The railroads in their operations lay out their work in advance, and I think it applicable to all kinds of business. Because the people in the South do so much logging, it is necessary to develop their roads; the heavy logging teams tear up the roads unless they have been laid out in a proper manner.

There is also another thing in which improvement could be made. When you are making a topographical map, you could check up and figure out the best scheme of working in that part of the country.

In connection with sawing, it seems the way to handle sawyers in the mill is to pay them on both quality and quantity of lumber produced. In other words, pay the sawyer, the edger and the trimmer by the piece. Put a premium on high-grade work; give them a small price for producing a low grade. The edger and trimmer should not keep track of what they do themselves. Have some one on each side of the mill to tally up what the others do. I know in one case they increased the quality of their labor 10 per cent, and everybody was satisfied, — better pleased than they were before. The sawyers were afraid of it in the first place, but it worked out. Some days they lose and some days they make money, but the average is better. The double standard kept every man in the mill on the jump. The company figures they average 10 per cent more out of it. They seldom push their men and the sawyers are better satisfied.

QUESTION: I should like to ask if any one here has taken up the question of rations for animals in logging camps. I should like to hear what different people feed, — the different rations.

ANSWER: I understand that molasses mixed in the grain is very effective, and we get a wheat that costs a little less than other grain, which is much used in the South.

MR. BROWN: We found that a great many of our horses had been overfed. We wanted to do the best for our horses and put more grain into the bin than was necessary, so a

good many of them died; we afterwards got a few feeders, men whose special duty it was to feed a large number of horses and take care of them at the same time, and in that way increased the worth and health of the horses. A veterinary goes about attending the horses in the forest camps.

QUESTION: How small a number of horses does it require a feeder for?

ANSWER: Thirty up.

QUESTION: Not worth while with less than thirty?

ANSWER: No.

MR. BROWN: We should like to hear from Mr. George A. Chedel, Superintendent of the Connecticut River Division of the Champlain Realty Company.

MR. CHEDEL: I can tell you about the system used by the International Paper Company, through its subsidiary and operating companies, in the lumbering operations.

In the management of lumbering operations, it is necessary to have an organization, in order that every care may be taken first of all to conserve the timber-lands themselves, that timber may be growing on the lands after the larger growth has been taken off, and to make it a profitable investment. In our system of management of lumbering operations, we first of all make a suitable main road onto the land which is to be operated. Only such timber should be used in the construction of roads and bridges as is of little value for lumber. After suitable roads are constructed, a camp and barn are necessary. A camp sufficient to accomodate forty men and a barn which will accomodate twelve horses are the thing.

Trees which are to be cut should be marked so that only such trees may be cut as, judging from their age, size and general appearance, have reached their growth. Usually, a twelve-inch diameter limit, two feet from the ground, is considered the right size, and anything under is to be left standing, unless it is an exposed location where there is a solid growth. It is then sometimes best to cut the entire growth, because if part of the growth is cut the remainder very frequently

blows down. When this is done it is practical, in a year or two after the timber has all been cut, to replant the land with nursery-grown stock, in either pine or spruce. Mountainous land, as a rule, produces spruce better than pine. Land that has produced spruce, if necessary to be replanted, should be planted in spruce. Norway Spruce under these conditions should be planted on account of its faster growth than the Red Spruce which grows naturally in this country.

After the timber has been cut and yarded, it is necessary to haul it to the mill or river bank in the cheapest possible way. This may be done in two ways. By two or four horses in a team, on two sleds, or, if the haul is a long one and the grade heavy, it may be desirable to use a traction engine, a very practical way where large quantities of logs are to be hauled over one road for a long distance. About the same kind of road has to be built for a traction engine as for a road operated by team. In all work in cutting and hauling to the mill or stream, great care must be used in looking after details, and no logs should be left in the woods which can possibly be used for pulp or lumber. Logs should be cut into the tops to a diameter of five inches in spruce, pine or hemlock. This size log can be used at the present time for either pulp-wood or lumber.

In this way there is less waste left on the ground and much less danger from fire. Where timber is of mixed growth and the cutting is only spruce and hemlock, and hardwood is left to protect the remaining growth, it is usually the best way to cut logs either twelve, fourteen or sixteen feet in length. Logs of this length can be hauled out onto the road with less damage to the remaining growth than timber cut in longer lengths. Where the cutting is done for mill purposes, it is frequently necessary to cut the timber around forty to fifty feet long. Where such cutting is done they practically take the entire growth, and the land after such operating is of very little value, for growth, for a long term of years. In our own cuttings, our logs are cut in short lengths to preserve remaining growth.

In each camp is a foreman, and usually in a camp of forty to fifty men, a clerk, who keeps the time of the men and does any necessary errands outside. The men are all hired by the foreman in charge of each camp and are graded, in wages, according to their capacity and skill in their work. The food supply for the camps is an important part, and care must be exercised that food of good quality shall be furnished in order to keep the men contented and satisfied; a satisfied stomach is just as necessary in the lumber camp as in the home. That the men may have suitable care in sickness, it is frequently desirable to have them cared for by some hospital. Under these conditions, when men are sick, they can have proper care. In a lumber camp it is almost impossible to take care of men who are sick, and, if it is attempted, it usually results in a large number of the men leaving. So we find that much the best way is to take them away to a hospital where they can be cared for.

The methods used by the larger companies in getting their logs to destination, whether by driving them in the streams or by a railroad, are practically the same. If they are driven, it means that the logs must be driven when the snow is melting in the early spring, when there is a large flow of water, and this means long days and rugged work while the work is being done. In this kind of work the men work fourteen hours, have four meals per day and are paid from $2 to $3 per day and boarded, according to their ability and skill in the work. If the delivery to destination is to be made by a logging railroad it is practical to haul the logs during the summer months, if the danger from setting fire to the forests can be eliminated in the dry season. The only safe way to do this is to maintain an effective patrol.

In accounting for the average operation, I should say the following general and special accounts would cover the situation:

*Camp Account*, to which would be charged all the labor supplies and materials used in the camps.

*Live Stock*, to which would be charged payments for live stock and veterinary expenses.

*Personal Property*, to which would be charged all expenses pertaining to sleds, chains, wagons, logging tools and camp equipage.

*Headquarters.* This would cover expense which could not at the time be charged directly to the camp account and would be necessary only where you were running several camps and must have a headquarters camp. To this account you would charge, if you did any farming, the expense of the farm work, and credit the account with the farm produce as delivered to the camps.

*Barn Account*, to which you would charge the cost of keeping and care of your teams, and also your horses during that part of the year when they were not being used in the camps.

*Log Expense Account* would cover the supervision of the operations by your walking-boss, scaling the logs, marking the trees for cutting and other similar expenses.

*Contractors' Account.* To this account would be charged the payments to contractors for delivering logs.

*Log Purchases* would cover the amount for logs purchased.

*Driving Expense* would cover the cost of driving, or if you wished, you could sub-divide the account to show the cost of the labor and the expenses separately.

*Log Sales.* To this account would be credited all sales of logs and also the logs delivered at your mill.

*Office Expense.* This account covers expenses of woods office.

*Log Account.* This would be a general account into which the other operating accounts would be closed at the end of the season.

To the above general accounts you might add a few special accounts.

*Road Account.* To this account you might charge the cost of roads which will accomodate more than one season's operations, and charge to each season its proportionate share.

*Camp Construction.* This would cover the cost of camps and be closed in the same way as your Road Account.

*Land Account.* This would cover the cost of your land.

*Timber-land Expense.* This would cover supervision of the land, surveying, fire protection and, if you do not wish to run a separate account, the taxes.

*Stumpage Account.* This account would be credited with all stumpage cut or sold and amounts collected for rentals, etc.

*General Expense.* This account would cover the home office expenses and salaries.

At the end of the operating season, you could close into the Log Account your operating accounts in such order as to show the cost per M. for your own operations, cost per M. for contracted logs, total cost of all operated logs on the cars or river bank; and after you have made your stumpage charge, their total cost, cost of all logs, either operated or purchased, cost of the logs driven and, after adding their proportion of your general expense, the total cost of your logs. Close into your Log Account your Log Sales and you will have the amount to be charged or credited to profit or loss.

## VII. ACADEMIC EFFICIENCY

Leader, EDWIN F. GAY

*Dean, The Graduate School of Business Administration, Harvard University*

MR. GAY: The subject set for discussion at this round table is Academic Efficiency. Interest in this subject has been inspired everywhere by Bulletin No. 5 of the Carnegie Foundation for the Advancement of Learning, by Morris Llewellyn Cooke, the title of that bulletin being *Academic and Industrial Efficiency.* That report presents the views of a business man, an expert in Scientific Management, concerning the extent to which principles of administration of the industrial world are applied in college and university administration.

I think the time has come when such a report should be considered seriously and not ridiculed. One may not agree

with all the suggestions it contains, but it seems to me that one must admit they are worthy of careful thought. Mr. Pritchett, after a careful study of conditions, says that in the financial side of college administration scientific business methods are obviously applicable. There is another side to which the methods of business are not so applicable; that is when we are dealing with incommensurable quantities such as scholarship and manhood. But there is a wide space between these two, largely directed to the methods of teaching, where the principles of Scientific Management may possibly be applied with effectiveness. Mr. Cooke proposes that the teaching staff be relieved of the business of administration, such as committee work, in order to allow more time for the teachers and researchers to specialize. This would require more work for the central administration. He proposes also that costs in education be determined in terms of some standard unit. There is much controversy on this point, for there are many things along academic lines which are not to be measured by cost. Taken from a broad point of view, however, there is a close relation between the cost and the output, even in research and the field of instruction.

Mr. Cooke offers one suggestion which is worthy of notice; that is a bureau of inspection. I have observed that it is not considered by some just the right thing for a member of the administration to visit classes and inspect them. There is not sufficient inspection of study and correlation in the method of instruction. I believe that the central office is justified in instituting a system of inspection to help the instructors teach, and moreover I believe it should be imposed upon them. I feel sure that any competent instructor would welcome and not resent such a plan.

Another suggestion which should be considered is the establishment of a better working day. My own impression is that we work too long hours and that the work is not properly ordered in those hours. We work overtime, but we do not work with sufficient intensity while we are at work.

On the side of the students I wish to emphasize the one need

seemingly most apparent. There should be something like vocational guidance for our students. There should be effort made to help them find out what they are fitted for and what they ought to work for. I do not mean any ordering of them, but careful aid. I believe many students go through college feeling the need of something they do not get there. I do not mean that studies should be wholly "practical" or vocational, but that in a broad sense they should be guided by a realization of their utility in later life. Indeed, this would strongly buttress cultural studies; if this aid could be given the students, their interest would be more aroused in all studies.

There are in the report many valuable suggestions bearing directly on administration. There should be more scientific business methods introduced into such departments as the office of the superintendent of buildings, more scientific janitor service, etc. There should be a publicity bureau. There is room also for increased efficiency in the registrar's office, in the management of finances and in accounting methods. There should be standardization in university administration in order to effect more efficient management and in order to afford more reliable comparison among colleges.

It is undoubtedly on this side that the more immediate result may be looked for in college administration from the newly aroused interest in Scientific Management. But we may hope that ultimately something of the spirit of Scientific Management, its thorough study of the work to be done, its thorough adjustment of means to the end, may give an added impulse to more efficient teaching.

It gives me pleasure to call upon Professor Edwin J. Bartlett, of the Department of Chemistry of Dartmouth College.

Mr. Bartlett: In the few minutes which I have been invited to use, I will not undertake to confirm or to confute the views which any individual may have expressed, but rather will try to open the subject broadly to our thought and our discussion.

And at the outset let me ask you to note that in business affairs the saving of time, of money, of effort does not of

itself bring increased efficiency even when efficiency can be accurately measured by dividends. If any captain of industry were to put me in charge of a business and I were to start for economy, without experience, grasp of the situation or business insight, I might begin by dismissing the expensive advertising manager, because from my point of view any one can write advertisements. I might go on to reduce the annual appropriation for advertising from $100,000 to $50,000, send departmental buyers to Europe only once instead of twice a year, allow them the minimum of traveling expenses and let them pay for their own luxuries since they have the fun of the trip, stop ten-cent lunches that cost the house fifteen cents, dispense with costly exhibits at fairs and expositions, keep the old machinery going as long as it can be patched up, eliminate every department that does not show a cash profit and do innumerable other things that any one can see might effect expenditure. These measures might easily be ruinous to the business unless the relation of each to the whole had been carefully studied out.

Even less can one be confident of the advantage of a similar course in our affairs.

We must set educational experience, insight and grasp over against the same qualities in business.

The primitive type of college was never better defined than as a log with a student at one end and Mark Hopkins at the other. But the students are many; the Mark Hopkins are few; lesser men take his place; and the log needs to be large and complicated to carry them all.

The college organization divides itself very sharply into two branches, — educational and subsidiary. They are not coordinate. The whole purpose of the college, its founders and benefactors lies in the first division; but the business framework is necessary. It is not to be admitted that education should be business-like except in the sense of being well organized and without waste; but it can be demanded that the business departments of a college shall be educational and form a constant exhibit and demonstration of efficiency.

Without attempting any exhaustive analysis we may say that the subsidiary departments readily divide into the following branches:

1. Finance; which deals with investments, collections and expenditures, — the department through which all the streams of money flow in and out.

2. Construction and Maintenance; which has charge of the important material basis, — the highly developed and specialized log upon which the modern college holds its sessions.

3. Records and Discipline; the college clearing-house; a cumbrous over-development which could be reduced to great simplicity if it were not that college students are not all students.

4. Publication.

5. Commissary; which enables the college to act as purveyor, as host and entertainer.

6. Sanitary; of enormous recent development, including medical care of the students, hygiene, gymnastics and athletics.

7. Statistical; much farther developed in some institutions than in others.

8. Social; including general correspondence, entertainments, functions and ceremonies.

9. The Library; which some might consider instructional, but which is classed here because of the large demand for organized administrative work.

Of the total net expenditures given in the Report of the Treasurer of Dartmouth College for 1910–11 about 42 per cent are for other purposes than instruction; while in 1880 about 29 per cent were for other than instructional purposes.

It would require very careful dissection of dissimilar accounts to obtain exactly parallel figures, because in this period of thirty years the college has not only remolded its accounts but has also taken on much more business and added many conveniences. About 75 per cent of the students room in college dormitories, instead of about 30 per cent as was the case thirty years ago; the college has taken on general

heating, lighting and water supply; everything is more sanitary, more comfortable, even more luxurious. But it is safe to say that the expense *per student* of the subsidiary departments, on a comparable basis has more than doubled, while the number of undergraduates has increased from 300 to 1,200. And at the same time the loss in going through college—the shrinkage of the classes in four years—is 40 per cent, while in the decades beginning and ending with 1880 it was only about 20 per cent of those entering. Plainly large business interests are involved and the question is suggested, "How much does the business side of a college cost per student?" the answer being more valuable according to the degree of distribution.

The various administrative departments of a college are related to the world outside of the college, to each other and to the primary college consisting of the teachers and students. They thus present complicated problems of organization which have been only crudely solved.

The side that faces the public in each case needs to show equality with the best business usage, it is to be hoped by adapting or originating, and not by imitating. Here offices, stenographers, business journeys are necessary. The employees take on the ways of the business world.

The complicated relations of the departments may be illustrated by a single case. A student is removed from college by a committee acting for the faculty. The action is based upon records collected from the student's instructors by one department. The student occupies a room rented in one office, and has a room key obtained in another; he has paid or failed to pay rent in another; he holds a laboratory table and key, and is due in at least five courses of instruction. The action must be communicated to all parties concerned and made a matter of record. Judging by the experience of a customer, the coördination of departments in business houses has been only crudely worked out. It is still more crude in the college. In this college, at any rate, it is constantly improving.

The relations of the business departments to the students and teachers require the best elementary business qualities. The students are keen, critical and suspicious; also they are in process of education and should be shown the best possible methods; and, since their own manners are largely formed by those in authority over them, they should be treated with the utmost courtesy and patience. The teachers have at least an adequate appreciation of what is due to themselves, but readily yield to reasonable rather than arbitrary presentations.

Unfailing courtesy, promptness, accuracy, readiness to acknowledge and correct errors, and a certain sense of the fitness of things, should characterize the employees in the business offices of a college; and this suggests a second question, "How can the college recruit men for the administrative departments with the proper business training?"

It should never be forgotten that all the accounting, recording, building, repairing and entertaining are mere details in the onward march of an institution for education. The occasional air of haughty autonomy and gloomy mystery in these departments is certainly misplaced. It is easy for a committee of clever business men on the corporation to issue a business order without looking or caring beyond a certain end in view, but some of the men who are giving their whole time to the college could help them in nearly every problem. Orders from the corporation would better come from the corporation itself rather than from a subordinate in another department. No department, whether of instruction or administration, should be dependent for repairs, heat, light, the adjustment of charts or apparatus upon the favor of any other department. It should be a matter of adjustment by some central authority, or manager, with both departments.

There are certain tests of business efficiency which can generally be applied in business, — the maintenance and expansion of the plant, the quality and quantity of the product, and always dividends. No such tests can be applied to the business departments of a college. A new building may be

the fruit of a gift, and may increase the annual deficit. No one can state the relation even approximately between the educational product and the efficiency of the heating plant. The dividends are in the unseen and intangible world. And this suggests a third question, "What is the standard and measure of the efficiency of the subsidiary departments of a college?"

I have perhaps given an illustration of the absorption by the business departments of more attention than is their due by the disproportionate time I have given to that side of the subject. But the real business of the college is educational, — to produce men for the state in physical, mental and moral fitness.

In the luminous future when all plans are matured in the cold light of scientific logic; when marriages, and the number, quality and sex of the progeny, a man's occupation and relation to his group, and the time when it is not worth while to feed him any longer, are all determined in the same inerrant manner, the economic waste which permits a man to go from Seattle or Lebanon to Harvard, or from Chicago or Denver to Dartmouth, will cease, and a student will choose his college on economic grounds, — the cheapest, or the nearest, or perhaps the one in which some special branch is best unfolded. At present the streams start far back and flow steadily. For next year's class not less than 400 nor more than 500 are marching hither from all over the land. For the most part it is a sentiment that marshals them.

Then, too, the love that binds a man for ever to his college, causing him to bring back gifts and to inspire others with his own enthusiasm, springs so little from an appreciation of the economy with which its educational advantages are managed, that one almost believes that broad spaces, generous rooms, artistic adornment, appliances made convenient to one department in one place and to another in another place, are attractive economy. A noble hall like Webster must leave some permanent impress upon a Dartmouth man although it has not been used two hours yet in this semester.

And not a dollar in all the millions of endowment represents

earnings, or subscriptions of the people to dividend-paying stock. Some one loved the college and its purpose, and gave outright a thousand, ten thousand, a million, dollars. And while waste of these great gifts would be criminal, one wonders whether they would come to an institution managed with the closeness of a factory. "There is that scattereth, and yet increaseth; and there is that withholdeth more than is meet, but it tendeth to poverty."

Neither the factory nor the home furnishes a model for the college; but if one must be chosen, let it be the home.

The great problems of economy over which the college teacher puzzles most,—the efficiency of his own teaching, the intellectual under-development and waste which he sees about him — cannot here be touched, but one final question can be thrown out, like the waves from a Marconi apparatus, to whomsoever is attuned to receive it, — "What is the measure of the efficiency of a college?"

MR. GAY: We should like to hear from Professor A. G. Webster, of the Department of Physics, Clark University.

MR. WEBSTER: In considering the question how far the methods of Scientific Management are applicable to academic affairs, we have first to consider whether there is any resemblance between the purposes of college and university activities and those of business. Here we are confronted at the very outset with a striking difference. The object of business is to make money, and to this consideration everything else is subordinated. In this very conference, several of the speakers have spoken of the necessity for the manager to have his eye always upon the balance sheet, and this sentiment has generally drawn applause. In the case of the college or university, nothing is farther from the truth. The object is not to make money. Unfortunately, there is a good deal of difference of opinion as to what the object is, and it would doubtless be a capital idea to come to an agreement on this matter. But we can say without much fear of contradiction, that its object is twofold; first, to develop the powers of the student and fit him to make his proper

contribution to life and civilization; and second, to advance civilization by making a direct contribution to learning by means of intelligent research. This last object is often lost sight of in this country. In fact, it has seemed to me that our business friends, the scientific managers, so willing to make suggestions with regard to the management of academic affairs, have had chiefly in mind technical schools, whose object is pretty definitely a business one. But this is far from being the general case. We have to teach men not only to earn a living, to construct engines, dynamos and telephones, but to live a correct life, to enjoy beauty and to ameliorate the conditions of life in general. Let us admit at once that in its purely business undertakings, such as the investment and disbursement of funds, the providing of buildings and care of grounds, the furnishing of food and lodging, a university should be guided by the same business considerations as any commercial undertaking. At the same time, the element of cost and of profit is even here not the main one, but efficiency is measured by the accomplishment of the object sought. Mr. Cooke may be able to make excellent suggestions with regard to the running of a physical laboratory, and yet be perfectly helpless when asked how to increase the efficiency of a course attempting to give an idea of the beauties of Shakespeare or Chaucer, or of a course in philosophy or Sanskrit.

Without doubt, the chief successes of Scientific Management have been due to the standardization of the output. In academic work such standardization is quite impossible, the object being not to turn out a large number of individuals exactly alike, but to have each one different from the others according to his manifold needs. This immediately negatives many of the leading methods applicable to business. But there are certainly some things that we can learn from business. The first is that we must have the best possible raw material to work upon. It is assumed in any business establishment that the main concern of every person connected with it is the interests of the establishment, and if this is not

the case, he is asked to leave. In the case of the colleges, this is far from being the case. The student body is largely diluted by the presence of persons whose chief interest is not any of the purposes for which our colleges were founded. This is a cause of great waste, and they should be summarily removed. Again, while our teaching body is composed of men of high character and ability, I believe that I may say without injustice, that their ability and training are not as great as they should be, and are inferior to those of the professorate in Germany, France and Italy. In order to remedy this, it is necessary to offer greater attractions for first-class ability to go into academic work, both by increase of salaries and by removing from professors the drudgery of business affairs and the teaching of unwilling and unfit students. Here either Scientific Management or what is the same thing, plain common sense, can be of great help. I do not believe, as it is often stated, that the best brains of the country are in business, but I do believe that the quality of professors can be very materially raised by an intelligent effort, such as has not been made up to the present.

I have received one very positive suggestion from the addresses that I have heard here. Mr. Taylor has stated that under conditions of Scientific Management, there is required a personnel of about one manager or planner to every three workers. The adoption of this ratio in the universities, of one instructor to every three students, would undoubtedly enormously increase the efficiency, as has been shown in the adoption of the preceptorial system at Princeton. It is also noticeable that in those institutions that are devoted to graduate work, where this ratio more nearly obtains, the efficiency is very high. Unfortunately, while in business the increased efficiency brings increased returns more than sufficient to pay the additional expense of the large managing staff, in the case of the university the increased efficiency is attended with no increased income. This is another of those fundamental differences which I have pointed out. The advantage to the community which accrues must, however,

eventually justify the increased expenditure, as has been found to be the case at Princeton.

The attempt to standardize the output of professors by counting the hours or by any system of cards or clocks, can be attended only with laughable results. All our best professors now work all the time that there is, and no one who is acquainted with their habits will admit that they have a working day of a definite number of hours, nor can they have. No one sits down to write poetry from nine to twelve, or has definite hours to engage in research in pure mathematics. He must do it when the idea occurs to him and it is just as likely to be in the middle of the night or on Sunday, as at any other time. The university does not pay the professor by the piece-rate, or by the task system. It gives him certain duties and expects him to perform them. Good business will undoubtedly demand that he shall be subject to inspection, for even among professors there will be some incompetents and some sluggards. The inspection, however, must be by competent hands. A man must be judged by a jury of his peers, and if he is what he ought to be, the number of his peers may be very limited. Rather than to provide a definite system to do this, the best and simplest way will probably be to find out the man's reputation among his scientific colleagues. In this connection, I may speak of methods of appointment of professors. In this country, these methods are often extremely crude. To be sure, presidents do not often now appoint personal favorites nor does political influence cut much figure, at least in this part of the country. The members of a department are generally consulted, and their advice usually taken. Very much better, however, is the plan adopted in most European countries, of having a qualified committee of experts in the subject nominate the best candidate, disregarding all other circumstances than those of competence. In Italy, this committee is composed of professors in the same subject from other universities as well as from the one where the vacancy exists. Such a plan must inevitably raise the quality.

I come finally to the question of research, so often overlooked in discussions of university efficiency. There is no doubt that this country has so far not contributed anything like her share to the advancement of learning which might properly be expected, considering her great prosperity and the size of her educational plant. We spend more on education than any other country, but we do not get a corresponding return. Some of the reasons for this I have tried to suggest.

In closing, let me strongly deprecate the valuation of research by any outsider; I mean by one who is not himself devoted to the advancement of learning as his chief pursuit, and who has not himself been an original producer. Nothing can do more to confirm the position of mediocrity in which this country finds itself in the status of learning, than the application of commercial judgments to matters that are essentially concerned with the spirit.

MR. GAY: In some of the womens' colleges, I understand, practical work is being done along the lines suggested in Mr. Cooke's report. We shall take unusual interest, therefore, in the remarks of the next speaker, Miss Laura Gill, President of the Association of Collegiate Alumnæ.

MISS GILL: The brief testimony which I wish to bring to this conference relates solely to the interest which women are showing in an application of Scientific Management to academic problems. Indeed, I may almost claim that the chief interest which women have yet evinced in Scientific Management has been because of this important application of it.

During the past months, since the issue of Mr. Cooke's pamphlet upon Academic Efficiency, I have tried to imagine what impression it might have made upon me had it found me unprepared for its views. So much of the comment has apparently arisen from a general lack of acquaintance with the principles and methods of Scientific Management that one is tempted to attribute a large share of adverse criticism to a conservative instinct to run to cover before an unknown force.

In February, 1910, Mr. Taylor invited to his house the committee of the Association of Collegiate Alumnæ which is composed of women who are trustees of colleges. He gave them an exposition of the philosophy of Scientific Management, and showed them its practical working in the plant of the Tabor Manufacturing Company. A week later Mr. Cooke gave an entire day to a conference with this same committee in Boston, initiating them still further into the possible application of these principles to committee work and to college administration.

So you can readily see that no one of us women trustees of colleges could read Mr. Cooke's report without the memory of explanations which destroyed interrogation points almost before they could be formed. Only one woman in our entire committee revealed any failure to comprehend that there was large significance for college administration in these new phases of exact knowledge, coöperation and legitimate economy.

The eagerness to reap an immediate harvest of increased efficiency was checked by an evident lack of trained agents to make the requisite studies. Vassar College, however, proved itself ready to make the preliminary start in a greater degree of systematized business control. A woman of wide practical experience was appointed without engrossing specific duties, to study each part of the business activities of the residence life *seriatim;* and to suggest, as well as to effect, improvements. The management of the bakeries and the laundry, and the greater division of the matrons' duties on functional lines, came duly to consideration with most satisfactory results. Whether this preliminary work shall go on to full fruit in any detailed application of Scientific Management, time alone will tell. But any modest beginning is valuable.

A meager study was made in May, 1910, in regard to the method of purchase and prices paid in New England colleges for diplomas. Yale University seemed to be the only institution which contracted separately for its parchment,

engraving and engrossing. The prices seemed to vary from seventy-five cents to a dollar and ten cents for practically the same product, according to the degree of specification in the method of purchase.

Harvard University has been introducing great economies into its stationery and printing budgets, not by any reduction in quality, but by reducing the number of forms, the number of buying centers, and by studying the placement of various insertions in their publications.

But to return to our womens' problem. We found that even any proper system of stores was temporarily impossible for lack of trained workers. Therefore, our next thought was to get some women under apprenticeship for stores supervision, award of printing contracts, and registrar's duties. The beginning is modest indeed, but today two college women are in apprenticeship approximately as are the young college men. Whether the impracticability of superintendence for women will prevent them from reaping the full benefit of such a training we shall soon see.

In any event, the women trustees of colleges are practically agreed that Scientific Management has a definite value for them in the functional management of dormitories; in the purchase, storage, and distribution of supplies; in printing; and in registrar's methods. How soon we can get proper agents to effect these economies of material and human force is a serious problem; but it does not destroy our belief that help is coming at last.

This, then, is a simple statement in regard to the extent of womens' interests in the application of Scientific Management to academic problems.

Mr. Gay: I call next upon Professor John K. Lord, of the Department of Latin in Dartmouth College. Professor Lord has shown not only long service of efficient teaching, but as acting president of Dartmouth College has been brought into close contact with problems of administration.

Mr. Lord: The report of Mr. Cooke upon Academic and Industrial Efficiency calls for a large measure of assent. One

must agree with very much of what he says of the application of Scientific Management to the finances, accounts, the care and use of buildings, equipment, purchasing, correspondence, and in general to all that goes under the designation of the "plant" of a college. Perhaps the application may be still further extended to matters that are not so directly in the line of business, as to questions of tenure, of salary and of burdensome duties.

The report is written with an evident sympathy for the difficulties of college administration, and it ought to be examined with a corresponding openness to suggestions of improvement by college administrators.

At the very outset of the report, however, one is impressed by the failure to recognize the fundamental difference between a college and a business corporation. There is an attempt to reduce them to a common denominator, and that denominator is "profits." "One is struck," says the report, "in any such study of collegiate conditions with the absence of any gage of efficiency which even remotely resembles, for instance, profits in an industrial undertaking."

With this idea of the profits of a business enterprise as the gage of efficiency, it is not strange that Mr. Cooke objects to many things that are done in a college, and regards them as waste, or on account of his system refuses to take them into consideration. He objects, for instance, to the waste of time and strength in committee work by members of a faculty; but he does not realize that, while there may be some waste and much weariness in it, there is nothing that so effectively brings a member of a faculty into direct and sympathetic relation to the inner life of a college, and into a knowledge of its vital problems, as work on an important committee.

Or again, in making a comparison of efficiency between the work of a college teacher and a workman in some business, he finds it necessary to throw out of his reckoning all that the teacher does except in the working hours that are common to him and the laborer. Thus he refuses to consider the time which the teacher devotes to his studies in his evenings or his

vacations, — time which is often indispensable for preparation and always for growth — without which it would be impossible for him to perform his class-room duties with the inspiration and enthusiasm that are essential to success, and that are drawn only from fresh study. With equal impropriety might it have been said that, because a laborer does not spend his evenings and holidays in occupations tending to increase his efficiency in his daily work, he therefore fails in efficiency in comparison with the college teacher. The standard of one cannot be the standard of the other.

Scientific Management, whose gage of efficiency is profits, cannot be applied to an organization that is not run for profits as it can be applied to one that is. A college looks to profit, but not to profits. Profit as applied to it, and profits as applied to a business enterprise, are incommensurable terms. The latter are exhibited in a balance sheet, based on cost of materials, labor, wear and tear, etc., each item of which can be definitely known; the product can be inventoried at a set market value, and at any given time the concern can be shown to be solvent or insolvent. The profits of a business concern are for the immediate benefit of its stockholders.

It is different with a college. It has no stockholders who look for dividends. Its profit is not for those who have given money for its support or for those who administer its affairs, but for society at large; and it is expressed not in dollars and cents, but in life and character. Such products cannot be inventoried or tagged with a market price, nor can they be secured at a definitely tabulated cost. Intelligence and morality are not bought at a price, but are the product of other intelligence and morality expressing themselves in close contact and often in indirect and unsuspected ways. A college is preëminently a place where the spiritual, in its broadest sense, holds control, and this is precisely what cannot be expressed in figures or shown in tabulated form. While it may be developed under definite, and to a certain extent formal, methods, it cannot be reduced to the measure of "student hours" as expressing its real content and meaning.

It is a matter of common remark that the power of a teacher does not depend primarily upon his knowledge, or his diligence as given in hours, but upon his personality, which makes use of knowledge and diligence as means in forwarding the great end of character. The power of sympathy and the ability to influence, which are the highest elements of a teacher's value, cannot be stated in any known formula. And fortunately these vary with different men. One teacher is effective with one student, another with another, so that in a given college one teacher may be effective with one set and not with another, or at one time and not at another, and there is no possible way of accurately establishing relative efficiency. In the long run one teacher may clearly be more effective than another, but the fact will appear from general comparisons covering considerable time, and not from a tabulation of particular results.

If Scientific Management means merely the attempt to secure the best results by a careful observation and a rational interpretation of facts, it is as applicable to a literary institution as elsewhere; but if it is a method of determining results on the basis of cost and profits, exhibited in a tabulated balance sheet, it cannot be so applied, since intellectual and moral forces, which are the staple of the college industry, cannot be reduced to the standard of the counting-room. There is much in Mr. Cooke's report relating to the business management of colleges for which those who administer them may be grateful, but they can hardly feel that the standard of the material shall become that of the intellectual and the spiritual.

Mr. Gay: Professor Charles W. Mixter, of the Department of Political Economy of the University of Vermont, is concerned with a field of research and of teaching which brings one into closer touch with the facts of business than does any other field of teaching. We are fortunate, therefore, that Professor Mixter could be with us.

Mr. Mixter: Our colleges and universities stand in such crying need of increased efficiency, and Mr. Cooke in performing a great service has been so unreasonably attacked

by many persons possessing but slight acquaintance with the principles of Scientific Management, that I am inclined to take up the cudgels in his defense. But he is able to defend himself; and therefore some remarks at the outset in adverse criticism may be of greater use.

In the first place it may be pointed out that Mr. Cooke in his report does not present a complete scheme for Scientific Management; he does not, generally speaking, get beyond suggestions for systematized management. That there is a vast difference between systematized management and Scientific Management has been fully demonstrated to us by Mr. Kendall in his address this afternoon. Nobody knows this any better, of course, than Mr. Cooke himself; and doubtless he had good reasons for not going extensively into Scientific Management. Nevertheless, I think it was an error of omission that he did not more fully indicate the ultimate destination of the movement he was forwarding. The time will come when the colleges will take up Scientific Management, and when they do, the work will begin just where Taylor began at the outset of the development of his system, — with the ascertainment by unit time-studies of what constitutes *for the students* "a fair day's work," and the devising of suitable means for securing the performance of that "fair day's work."

On the other hand, I think it was an error that Mr. Cooke said anything at all just now about change in tenure of office for professors, about the economic waste undoubtedly connected with insufficiently controlled research work and about the possibility of the introduction of standardized lecture notes. I am not saying that he was not right in his position on these matters. It may be that we shall live to see a marked modification of the theory and practice of the tenure of appointment of college professors, and also, what now seems incredible, that we shall all like it. It is a principle of Scientific Management applied to industry not to discharge men right and left to secure efficiency, but to select them and change them about within the establishment until they are placed in positions for which they are fitted. If the time ever

comes (as Mr. Cooke hints) when professors are changed about freely between institutions with no stigma attached, so that each finds just the situation where he can be most successful and happy in his work, we shall undoubtedly welcome the change. But whatever may be the solution of the problem of reconciling security of tenure of office with teaching efficiency, and whether or not there is a future for "standardized lecture notes" (and I think there is, if by "lecture notes" we mean syllabuses for whole courses), it is certain that it was a mistake for Mr. Cooke to say anything about these things in the incomplete way he did at this time. He needlessly set the whole academic world and the New York *Evening Post* by the ears.

In the remainder of my time permit me to develop briefly, and in a somewhat dogmatic form which I hope you will pardon, some suggestions for systematized management of our colleges, following in most particulars the lead and inspiration of Mr. Cooke. In the first place we need an "organization chart" and an "organization record" showing clearly the line of authority for each individual together with his duties in detail. Then, too, we need far more internal publicity,—the publication for the information of the faculty of all sorts of significant statistics. But chief of all we require a careful analysis of work, and differentiation of function in the workers.

We should distinguish between administration and teaching, and between different sorts of administration, and should always have designated officials (not necessarily in each case separate persons) perform the different functions. Administrative work which is pure business, — the management of finances, care of buildings and grounds, the purchasing of routine supplies and the like — should be done entirely by members of an administrative staff who have no part in the work of instruction. The executive chief of this group of officials should be the Treasurer or some representative of the Treasurer's office, such as a Comptroller. That part of administration which is not pure business, or teaching either, but administration directly affected with an academic interest,

should be handled upon the principle of segregation of function, but with care taken not to carry that principle too far. Academic ideals are involved; it is essential that the spirit of scholastic enthusiasm be not blunted nor institutional unity destroyed.

The general scope of the institution being determined by the trustees—what schools there shall be, leading to what degrees—the work of administration that overlaps the work of instruction falls naturally into the four following subdivisions:

1. The function of "drafting," which consists in organizing and grouping the individual courses of instruction and making the rules for the students respecting their studies,—i.e., planning how they shall "go through the shop," what sort of an education they shall get. The projects of law under this head should be formulated by a standing committee of the faculty, known as the Bureau of Design and Standards, and enacted into law by the whole faculty.

2. The function of "routing and despatching," which consists in the execution of the plans made by those charged with the drafting function—the "enrolment" of students, the arrangement of the "hour plan" and similar things. This work should be done by the Despatcher, a non-teaching official of the administrative staff.

3. The function of the determination of standards: standards for admission; standards for promotion and graduation; standards for scholarships and other student aids; standards of eligibility for playing on the athletic teams. The fixing of these and other standards should be done by the Bureau of Design and Standards: i.e., this faculty board should formulate definite proposals which go into effect only upon enactment by the faculty as a whole.

4. The function of maintenance of standards. It is absolutely essential if standards are to be maintained that this function should be discharged by members of the administrative staff having at the time no work of instruction, although they should have had wide teaching experience. The point is not so much that active teachers will not have time

for this work, as that they simply cannot do it properly. They are not expert and detached enough.

To indicate briefly the duties of the two chief officials performing this class of work. The Supervisor of Admission should have charge of the fulfilment of the requirements for admission. Not only should he attend to the routine aspects of his task with the thoroughness of an expert, but also he should magnify his office and make himself fully acquainted with the work of the preparatory schools. He should keep records of students' performance after entering college, classified according to the schools they come from and according to the sort of preparation they have had. He should act as an adviser to the Bureau of Design and Standards in improving requirements and methods of admission. In time, under such a system, it is to be hoped that all colleges will admit upon the basis of the whole record of the student in his preparatory school, rather than on the basis of specifications calling for particular studies and the "grades" in those studies.

Then there should be the Inspector of Progress of Students who, in the first place, should have general control over the system of examinations for matriculates, — control to the extent of securing sufficient and reliable data as to the work of the students. He should be careful, of course, not to interfere unduly with the officers of instruction who necessarily do the examining; but these should not be left free as at present to be as much "out of line" as they see fit. The endeavor should be made by the Inspector (by furnishing forms and clerical assistance) to get from the instructors detailed student performance reports, in place of the time-honored "grades."

The Inspector, through his assistants, should obtain complete and accurate records of attendance of students. He alone should grant permits for exemptions and irregularities touching scholastic work and pass on all excuses. By means of a corps of official coaches (not necessarily a large and very expensive body, as Mr. Cooke points out) he should show deficient students how to study, and ascertain whether they

are delinquent rather than merely slow and hard to learn. With the best of intentions many students go through the motions merely of study; there is speed and feed of a sort, but no "depth of cut." Others are of the sort that do not care and do not try, and whose presence in college is demoralizing to the whole student body. With the Inspector should be lodged the sole power of dropping students and otherwise disciplining them individually, appeal from his decisions allowable only to the President. If the Inspector is not a success, the President should put a new man in his place, not weaken or abolish the office. I have no doubt but that in most colleges, as Mr. Cooke intimates, this one innovation alone would greatly reduce the amount of "spoiled work" — students who needlessly fall by the way.

Moreover, if in any college the Inspector of Progress of Students had his corps of coaches well established, these men could make the unit time-studies and carry on other investigations which eventually would furnish the basis for installing completely developed Scientific Management. The Despatcher should not be a mere rule-of-thumb functionary, but able and enterprising, and capable of making improvements in the art of arranging hour plans and scheduling students, regulars and irregulars, through their courses. Then it would be possible to introduce an automatic incentive to good work which is wholly lacking under existing lock-step arrangements for promotion and graduation. Colleges are now like an old-style time-wage workshop in which the men are paid for their time, — not for their performance — and the performance, for the most part, is only such as to avoid by a fairly safe margin the danger of dismissal.

In this connection I wish to endorse a suggestion of Mr. Cooke, that there ought to be a coach or coaches for the faculty, especially for the younger and less experienced members. These last need to be shown how to teach and properly police their class-rooms, and possible neglect of duty should be safeguarded. At present, instructors as well as students are usually left altogether too much to their own devices;

and the hours for both are often excessive. The work of supervision of the faculty should be done as a regular thing and not exceptionally, and of course under the direction of some person other than the one occupying the office of Inspector of Progress of Students.

There are various other academic administrative functions of importance that I have no time to deal with beyond urging that as far as possible in each case they be committed to the charge of a man rather than a committee. Many of these tasks are not so arduous, and do not call for such special expertness or detachment, that they cannot be effectively performed by members of the teaching staff.

In place of the wofully inefficient, time-wasting committee system now in vogue in colleges, there should be in general a ministerial system, with an inner circle of the more important ministers forming the President's Cabinet. The Cabinet should meet regularly at least once a week, with the President (or in his absence the Vice-President) in the chair. Its membership (varying at times according to the sort of business to the fore) might be as follows:

1. The Comptroller. (The representative of the Treasurer — the budget chief, and chief of the department of material services.)

2. The Dean of the Faculty. (The supervisor of the instructors, not of the students.)

3. The Chairman of the Bureau of Design and Standards.

4. The Supervisor of Admission.

5. The Inspector of Progress of Students.

6. The Despatcher (who might also be Statistician).

7. The Supervisor of Health, Morals, "Outside-Work" and Living Conditions of the Students.

All legislative measures should be passed upon by the Cabinet before presentation to the general faculty. Important measures should be amended only by the Cabinet, upon suggestion of the faculty, and then resubmitted as amended to the faculty.[1]

[1] For further discussion *see* pp. 356, 358, 362–365, 370–376.

## Fifth Session

FRIDAY EVENING, OCTOBER THE THIRTEENTH

CHAIRMAN, HONORABLE ROBERT P. BASS

*Governor of New Hampshire*

# SCIENTIFIC MANAGEMENT AND GOVERNMENT

## INTRODUCTION BY THE CHAIRMAN

LADIES AND GENTLEMEN:

I TAKE it that the chief requisite of a presiding officer at a meeting of this sort is brevity. This evening's session of our conference is to be devoted to the application of business methods to the government of states and we are to be so fortunate as to hear this subject discussed by a man who has not only developed an efficient and systematic business method of conducting the finances of great municipalities, but also has been able to get his ideas actually put into practice. In recognition of his scientific achievements in this and other directions he was appointed by President Taft to the chairmanship of The President's Commission on Economy and Efficiency. I have the honor of introducing to you Dr. Frederick A. Cleveland.

## THE APPLICATION OF SCIENTIFIC MANAGEMENT TO THE ACTIVITIES OF THE STATE

BY FREDERICK A. CLEVELAND
*Director of the Bureaus of Municipal Research of New York and of Philadelphia*
*Chairman of the President's Commission on Economy and Efficiency*

MR. CHAIRMAN, LADIES AND GENTLEMEN:

IT is commonly assumed that the great public corporations in which we are all interested do not lend themselves as well to economic management as do private corporations. While experience has been such as to lend color to such a conclusion, I am convinced that there is nothing inherent in gov-

ernment which stands in the way of highest efficiency; that the fault has been not in our form of government but in the attitude of the people towards the government. So general is the opinion that the fault lies with the form of government, however, that before entering on the subject of Scientific Management as applied to the state, I want to call your attention to certain aspects of organization which at least point in another direction.

Scientific Management, as I understand the term, means the intelligent direction and control of affairs, — direction and control based on complete, accurate and well-digested information. The activities of the state to which application is to be made are those activities which are to be managed. That is, *management* has to do with the business conducted by the administration as distinct from that which is conducted by the legislature and by the courts. In so far as legislation has to do with determining what is to be done, however, this may also be considered as a part of management.

*The Meaning of Scientific Management.* The full meaning of Scientific Management is comprehended in the word "planning" and in the phrase "the execution of plans." As applied to the state, "planning" is understood to mean the intelligent determination of:

1. What work is to be done.
2. What organization shall be provided.
3. What personnel is required.
4. What funds and material and equipment are needed to enable the personnel to execute work efficiently.
5. By what means the funds, material and equipment needed shall be obtained.

"The execution of plans," as distinguished from "planning," is understood to mean:

1. Directing or selecting the personnel, the material, equipment, and the technical methods employed in executing each piece of work, or "job," which is to be undertaken.
2. Giving orders in such form and with such instruction that they may be understood.

3. Inspecting and reviewing each result as a means of determining whether each order has been properly executed.

4. Obtaining the information needed to give perspective; i.e., collecting, classifying and summarizing the facts about the business, and making them available in such form that the manager may at all times see the business as a whole. The manager needs to get the mental picture of each condition and result for which he is responsible. He needs to see the net result as well as such detail as is necessary to explain conditions and net results, thereby enabling him to review decisions made, and orders issued; to locate responsibility for failures and losses; to determine what part of the organization is efficient and what part is inefficient; to know exactly what has been purchased, what has been paid for things purchased and which things are adapted to the use for which purchased; to ascertain where economies may be effected and wastes stopped; to find out whether unsatisfactory results are due to failure on the part of those who are "executing" or due to lack of intelligence on the part of those who are "planning."

5. In addition to these processes, and as an incident to Scientific Management, he who *executes plans* should also report conditions and the results of action to those who are responsible for "planning," with recommendations looking towards a better adaptation of the organization and material equipment to the work to be done, and with estimates based on experience setting forth the funds and authorizations required to carry on the business with highest success.

Assuming that this is all comprehended in the term scientific management of the business of the state and considering the many subjects which may come before those responsible for the conduct of public affairs, it must be apparent that several volumes might be written without exhausting the topic assigned for this address. You will be relieved, therefore, when I say that I do not intend to discuss more than one phase of it; viz., the instruments of precision which are available to the managers of public institutions. In fact, the topic has been still further narrowed to a few suggestions

pertaining to those instruments of precision which are available, but which have not been generally used as a means of obtaining the information needed by managers for accurately thinking about public business.

*State Constitutions and Municipal Charters Based on Principles of Scientific Management.* Before taking up this phase of the information side of the subject, however, may I not be indulged in one other general observation; viz., that the institutions of democracy are cast on practically the same lines as are the institutions of private business; that the modern democratic state finds its prototype in the modern private business corporation; that in the age-long conflict between autocracy (or incorporated privilege) and democracy (or organized citizenship) the devices which were evolved by citizens for the successful prosecution of private business, for locating responsibility, for "planning and the executing of plans," were insinuated into their charters of government; until finally in this country, at least, the last vestige of legal authority based on organized privilege was cast off, and in the reorganization of our institutions the citizen was given the same place and interest in the public corporation that the shareholder has in the private corporation.

It may be of interest in this relation hastily to review the constitutional and charter provisions which have been made for Scientific Management. The underlying theory of the American commonwealth is: that it is a highly refined trusteeship, in which the citizen is both sovereign and beneficiary; the corporation (the government) has been incorporated by the citizen sovereign as his trustee; public welfare and public funds and properties are the entrusted interest and estate. In incorporating this governing agency every precaution has been taken to make the officers both responsive to the sovereign will and responsible to citizenship for the proper execution of powers devolving upon them. To this end it is provided that the powers of government shall be exercised by two classes, an electorate and an official class.

The purpose of the electorate is to provide a non-official

class whose duties shall be to determine and express the popular will:

1. With respect to all subjects having to do with the modification of the articles of incorporation — the *amendment of Constitution.*

2. With respect to the succession of governing agents — the *election* and *recall* of officers.

3. With respect to certain other fundamental questions which are referred to the people by the official class, or otherwise — the *initiative* and the *referendum.*

This is the provision made by shareholders for regularly expressing their views on subjects of common welfare.

The purpose of the official class is to execute the powers essential to "planning" and to the "execution of plans," i.e., to manage the estate for the purposes set forth in the deed of trust — the Constitution. To the end that management may be scientific (and at the same time both responsive and responsible to citizenship), our constitutions require the coöperation of both legislative and administrative agents in order to do business, — i.e., the legislature must decide what is to be done, what organization and equipment shall be provided, and what funds should be granted; and the administrative agents must be relied on to execute these plans, subject to review by both the legislature and the courts.

*Instruments of Precision Available to Public Officers.* Science assumes, as a basis for its conclusions, accurate information. Management, as a subject to which methods of science are applied, is no exception. Accurate information pertaining to management requires the use of instruments of precision. Among the instruments of precision which have been invented for use in management, and which are usually left out of the list of equipment provided for the management of public institutions, are the following:

1. A scientific budget.
2. A balance sheet.
3. An operation account.
4. A system of detail cost and efficiency records and reports.

I do not wish you to understand that I am suggesting that these are all of the instruments of precision available to the managers of state institutions. They are simply the ones that I have chosen for discussion this evening. In going over the general list of processes which are involved in planning and in executing plans, it is obvious that but few processes are included within these topics. They are taken, however, as forming a part of a group having to do with the business of government.

Perhaps you think that I have gone far afield to speak of these as instruments of precision; you may question whether they belong to the same category as micrometers, speedometers, thermometers and the like. On second thought, however, I think that you will agree that for purpose of management these instruments are properly classified.

*The Budget as an Instrument of Precision.* For institutional "planning," a scientific budget is the best known and most highly developed instrument of precision that has yet been devised.

If the legislature is to act intelligently on questions of policy, and if this branch of the service is to be held to a strict accountability, there must be some means provided for presenting a definite program to be financed; each new legislature must have laid before it an accurate statement showing exactly what has been done and what is proposed; and this statement should be prepared by those who are in position to obtain accurate information as a basis for official judgment as well as for the consideration of citizens whose opinions may be expressed through publicity agencies, petition, remonstrances, etc., and who express themselves authoritatively through the electorate. This end is accomplished by having a statement of what has been done, and of proposals for future work, submitted by executive officers. The statements thus proposed are required to be submitted to legislative agents — those charged with responsibility for adopting plans; the plans when adopted by the legislature, however, are subject to veto or expressed disapproval by the "executive."

In view of these provisions, the conclusion seems fully warranted that our state constitutions and municipal charters amply provide for intelligent and efficient "planning," and for locating responsibility for unintelligence, for neglect of duty, for bad judgment and for failure to measure up to the requirements.

That is to say, those who are responsible for administering state governments and municipalities, those who are in the best position to do so, are required to submit in the form of a budget, a definite plan, or proposal, to be financed. The estimates are required by law to be prepared by what we may call our "functional managers." Those who have to deal with the problem of protecting life and property, and with the preservation of order, are required to present a definite plan for policing; those who are charged with the technical and highly expert methods required to protect and promote the health of the state or municipality must submit a definite, concrete plan for doing so, with an estimate of what it will cost; those who are responsible for the care of the dependent, defective and delinquent, for the construction and maintenance of streets, bridges and sewers, for the promotion of education, art and recreation, for the management of public service enterprises, are required to submit in detail their plans; while those who are responsible for the general business and finances of the government are required to assemble all these details and state them in the form of a budget of estimates of expenditures and of revenues required to meet them.

If the budget is scientifically prepared, if it is presented for the consideration of the legislature and of the people in such form that the "plan" proposed may be readily grasped, if the facts are arranged in such manner that complete information is readily available for the consideration of every question of policy to be considered, then the legislature and each member may be held responsible for the faithful and efficient discharge of duty. The appropriation bill, as a mandate to be executed, will mean something to the executive and to the people. The executive will be in the position of

first having submitted a plan for consideration and of accepting or vetoing a plan adopted. If passed over his veto, he may then accept responsibility for refusing to obey the mandate of the legislature, i.e., refusing to spend its money for the purposes authorized; and may go before the people on the issue raised.

In other words, what I wish to get before you as a principle is this: that in the first place our public corporations have been organized with a view to planning and executing plans, that our legislature, acting in the capacity of representative of the people, usually comes into office with little experience in governing, but, being responsible for deciding on plans to be executed under terms of public policy, in order to make such agency effective, finds it is necessary to have the expert agents of government prepare those plans and submit them to the legislature. By so doing, the legislature is made responsible for either accepting or rejecting those plans which have been prepared by the managers. Having accepted the plans, they assume responsibility for their acceptance. Having rejected the plans, the executive who has prepared and submitted the plans then has the right to veto the mandate of the legislature, which comes to him in the form of an appropriation bill. In case his veto is overruled, then he has the right to refuse to execute that mandate and go back to the people with the issue. In the State of New Hampshire and in some other states, he may prorogue the legislature to get the issue before the people. Where there is no power of prorogation, the question goes over till the next legislature, unless the people have a recall or some other method of holding officers to responsibility.

As an instrument of precision the budget has not been properly used. Both governing agents and the people have been without a conscious program of government. Estimates required by law are submitted as a mass of technical detail; they are not prepared in such manner that they may be classified and summarized; they are not presented in the form of a program or prospectus which may be

seen in perspective and understood by the layman, or even by a large majority of the officers themselves. The result is that management is necessarily unscientific and disappointing; work is authorized by the legislature, organization is provided for work and funds are voted in response to personal pressure and expressions of local interest; welfare questions are settled without regard to the consideration of public policy, and in such manner that they may not be publicly discussed; laws are made, appropriations are passed and conditions attached to authorizations to spend, on private understandings and by a scheme of legislative "log-rolling."

*Instruments of Precision for Use of Executive Officers.* As has been suggested, the budget is an instrument of precision for use in legislative "planning,"—a prospectus of business. The estimate is designed for the purpose of outlining a definite administrative proposal as a basis for action. The act of appropriation is in the nature of a mandate of the policy-determining branch. This instrument has been devised by representatives of the people, in conflict with those who represented organized and incorporated privilege under a régime of monarchy. The budget is seldom used in the management of private business. The other instruments of precision to which attention is asked are primarily for the information of those who are charged with "executing plans." They have been designed and developed in their best form by managers of private enterprises.

*The balance sheet* is an instrument to be used by one who, though accountable for every act of subordinates, as for a trust, is far removed from the varied activities and details which make up the business that he dominates; it is an instrument by means of which the manager responsible for the execution of the plans and policies of the corporation may have his attention directed to subjects of immediate administrative concern. As an instrument of precision it is quite as available and quite as useful to a state or municipal officer as to the head of a private corporation. To the manager it

serves the same purpose as the contour map and chart of movements to the military leader; by this means the officer is able to watch in perspective the varied activities around him; to give direction and to relate this perspective to the conditions surrounding and results following each movement; in short, the purpose of the balance sheet is to serve the manager as an instrument for determining at all times both present condition and net result, — to give to him a sense of proportion and relation that he can gain in no other way.

As an instrument of precision for reflecting present financial conditions, the balance sheet is adapted to giving not only the relation of resources to liabilities and surplus to deficit, but also to reflecting present conditions of appropriations and other authorizations to incur liabilities and to spend. By the use of a balance sheet, the officer may have prompt, complete and accurate information needed for thinking about every financial relation within his control.

Notwithstanding the general use of the balance sheet by officers of private corporations, it is seldom employed by officers of states and municipalities. In not being provided with such an instrument, they are seriously handicapped by a lack of means to obtain prompt, accurate and complete information. The state or municipality is made less efficient as an agency of welfare, the people are without the data needed for the consideration of matters of serious importance pertaining to business in hand and legislators are without the information necessary to the consideration of future plans.

Another important instrument of business precision which has been developed by private experience and which is available to the managers of state institutions is *the operation account.* This is a form of statement showing on the one side the cost incurred in conducting each branch of business, and on the other side the income accrued to meet this cost. The operation account was devised because of the inaccuracy and incompleteness of statements of cash receipts and cash disbursements. Costs may be incurred which have not yet been paid; income may be accrued which has not yet been

collected; payments may be made in advance; revenues may be prepaid; and in the cash there may be receipts and payments that have nothing to do with either expenditure or income.

The inaccuracies and incompleteness of the data pertaining to the relation of cost to income, when taken from accounts showing transactions in cash, are even more striking in state and municipal business: taxes may not be collected for many years; the expenses may be largely paid out of borrowings; the revenues accrued are usually collectable, but if not collected, accounts and reports which are based on receipts may lead officers far afield, i.e., may be the cause of reaching unsound and dangerous conclusions. Notwithstanding this fact, few public corporations have provided their officers with such an instrument of precision. Government managers are supposed to think, act and direct with judgment, without exact knowledge of the relation between cost of operation and income to meet this cost.

Much has been said of late about the need for increased economy and efficiency in the management of public affairs. Generally speaking, the officer is charged with any action taken which may result in waste, whether this be from the character of purchases made, or the character of work performed. Few have asked themselves the question whether the officer is adequately equipped with instruments of precision for determining and having regularly brought to his attention evidence of waste and inefficiency.

Generally speaking, a person who enjoys the confidence and respect of his fellows, who has attained marked success in the management of private affairs, when elected to office finds himself without the means of knowing what is being bought; what price is being paid; whether the thing purchased is adapted to use; whether things purchased and paid for are actually delivered; whether the things delivered are used and properly accounted for; whether employees are efficient or inefficient, faithful or faithless; what is the cost of any product or job; and what is the relation of cost to result.

I think Governor Bass will agree with me in the statement that, when a new executive first sits down in front of the official desk, he finds the same stream of business flowing over his desk the first day he enters office that flowed over it the day before his predecessor left office. In taking office he usually takes up a new business. He has been chosen to office because the people believe in him, but it is not assumed that he has any knowledge of the business to which he has been elected or for which he is responsible. With this stream of business demanding immediate attention and concerning which he knows nothing, he must sign and sign; the official signature must be attached hour after hour, day after day and month after month, or business will stop; he must sign, relying either on the verbal statements or perhaps on the initial of some one in the office who says, "It's all right, Governor; it's all right. Please sign here."

In this situation he is asked each day to make decisions, give orders, execute contracts, sign vouchers for the expenditure of public moneys, release fidelity and surety bonds, — to do all these things on the verbal statements or initials of subordinates, without the means of obtaining the data necessary to the location of responsibility for misstatements of fact or for the administration of discipline. On the other hand, subordinates are without the protection of a record earned. The whole plan of business organization and method is on a plane of personal relation and ignorance, instead of on the plane of a system of merit and intelligence.

In conclusion it may be said that both governing agents and citizens, electors and non-electors, are without any conscious constructive program of government. Though an electorate has been created to enforce responsibility, it is without facts; the people cannot hold legislators responsible for failure properly to represent the people; legislators, responsible for determining questions of policy and voting funds, are both without a well-defined plan or program to consider, and without the information necessary to the consideration of questions of policy; the officers responsible for

the execution of policies and mandates of the legislature, under acts of appropriation, are without the proper instruments of precision for obtaining prompt, complete and accurate information about the business in hand. Under such circumstances, it goes without saying that the affairs of the government cannot be scientifically managed, — that is, under present conditions public business, whether national, state or municipal, cannot be intelligently directed and controlled.

Generally speaking, the budget should raise every question of policy pertaining to decisions as to what should be done, what organization should be provided for doing the thing which is decided on and what character of expenditure should be financed. So far as I know, there is not a state in the United States that gets before the legislature through its experts, i.e., through the administration, the information necessary to the consideration of any of these questions. Suppose that the subject be one of public health. What information has the legislature on which to decide questions of policy? In order to determine what plan should be made with respect to public health, they should know not only what is being done at the present time by the state, by the municipality, by the federal government in matters of health, but they should know also the needs of the people with respect to health. They should know what part of that need is being met and what part is not being met. Questions of policing, questions of sewage, questions of transportation, of housing, of what not, must be approached in the same manner. The fact is that the legislator, not being able to see the problem which is presented, cannot think of it properly in terms of work to be done, what organization should be provided, and what character of expenditure should be made; he cannot determine what amount is needed for current expenses or for fixed charges or for capital outlays. There are very few of our public corporations that have even a list of their properties, to say nothing of information concerning what is needed to serve the public in matters of health, or education, or any other subject of public interest. There are some of our

public corporations which have been so ignorant of what they owned that they have bid in their own property at a tax sale. Others have bought sites for schoolhouses in the same block in which some other department had property which had been lying idle for twenty years. When public business is run on such a plane as this, and when the legislator does not have presented to him the facts necessary to a proper consideration of a subject, we cannot expect intelligent action on the part of the legislator, nor can we hold him responsible for failure to act intelligently in the discharge of his duties.

Very few private corporations have undertaken to finance a business which places a greater burden of responsibility on the management than does the modern public corporation. Yet the officers elected to direct and control the business of a government are handicapped in a manner which would at once mark them for immediate failure as managers of a private corporation. When so inadequately provided with instruments, what is more natural than that those, who by reason of their previous successes, have been honored by electors with positions of public trust, should retire discredited; and under such circumstances, what else is to be expected than that voters who have elected men to office, finding them discredited, should turn to others who make new promises, — and who, when elected, themselves become quite as helpless as their predecessors? With rare exceptions, election to public office has been a sentence to political death. In each case, the man of good motive who has gone out of office discredited, has been the victim of institutional methods which spell inefficiency. Not only as officers, therefore, but also as citizens, are we all interested in placing in the hands of public officials such instruments of precision as will enable them to have the same basis for intelligent direction and control, the same means of protecting responsibility and for "making good" for the benefit of the public, as have been made available to him when working for the benefit of private stockholders.

*The Causes of Popular Despondency.* Notwithstanding this

splendid plan for making government management intelligent and for making governing agents responsible and responsive, the American commonwealth has suffered more from ignorance, irresponsiveness and irresponsibility during the last half-century, than have many of the monarchies of Europe. Furthermore, the welfare of the people has not been carefully guarded, the entrusted estate has been wasted, the activities of the government have been inefficiently managed and powers of government have been systematically prostituted to private and partizan ends.

I will not attempt to enumerate all of the causes, but may I not suggest that one of the conditions giving rise to popular disappointment has been lack of exact knowledge, — to put it baldly, has been both popular and official ignorance? Since neither the people in their capacity of sovereign or in their capacity as beneficiary, nor their official agents in the capacity of trustees, have worked out any well-considered plan of business, our people have had no sovereign will to be expressed; the electorate has not and cannot record opinion; our institutions, national and state, have been running a fortuitous course in the dark, directed by officers without a compass and without a sailing chart.

Under a plan of political organization which rests on citizen sovereignty; which takes its managers (both those who "plan" and those who "execute plans") periodically from the rank and file of the people; in which the legislature must depend on expressions of popular will for support to policies determined, and executives must depend for success on support which comes from the people through an electorate; the information on which judgment and action are based must reach through the officer to the people, for whose benefit institutions are organized and maintained.

And until the instruments of precision which are available for this purpose are properly used, let us not speak disrespectfully of the "political boss." Under present conditions the "boss" is the most scientific citizen that we have. In the large cities, the "political boss" is the only one who in any

manner represents organized citizenship. True, his guiding motives may not be public welfare, but until the present at least, "the boss" has had a clearer concept of the essential factors of democracy than has "the reformer." He has the astuteness to see the need for keeping himself informed concerning community wants; he is the only one who has made it his business to supply community needs; he is the only one who has had a definite, and at times, comprehensive citizen program. He makes provisions for systematic contact with citizen activities, citizen opinion, citizen interest and citizen needs, in order that he may have the information necessary to win suffrages of a less well-informed electorate, that he may obtain for himself and for his organization patronage through which to gain the contact needed for the exercise of the powers which will permit the use of funds and properties entrusted to officers of governments, and to avail of these for partizan and personal ends.

"The boss" makes citizenship his business. The men and women whose interests are to be served have not as yet recognized the need for a definite plan or program to be executed; they have not demanded, nor has the legislature as their representatives provided, the means whereby those who execute may coöperate under scientific management in executing a plan or program. The business of citizens, as citizens, has not been seriously and intelligently undertaken, and the powers of the electorate have not been intelligently and effectively used to support those in office who are interested in the honest, efficient and economic management of public affairs. Officers have undertaken to discharge their duties under a handicap that makes the highest success impossible. So long as this condition obtains, the best solution that democracy can offer state and municipal government is domination by "the boss." Under present conditions it must be conceded that popular sovereignty has been a vicarious reign — an idealistic dream; that "boss rule" has been the reality; that our popular sovereign is still in infancy; that our state regent is the "political boss"; that the differ-

ence in principle between North American democracy and Spanish American democracy has been that in Spanish America the "political boss" has established his office in the state-house or in the town hall, while in the United States a willing or unwilling tool of "the boss," receiving the suffrages of an ignorant electorate, has given the stamp of approval to official acts, — the real business of the government being done in a private office outside of the state-house or town hall.

Gov. Bass: This will close our session this evening unless there are questions which you care to ask of Dr. Cleveland. He has kindly offered to answer any questions which you may have to put.

Question: I should like to ask him what we are going to do about it?

Mr. Cleveland: It occurs to me that, notwithstanding all of the discouragement that has been expressed about the manner in which our government affairs have been conducted, we can look forward with a great deal of confidence to the future. In the first place, citizenship has been aroused. The first one hundred years of experience in the United States was one which caused the citizen to think of the government as an institution that had been organized and maintained for the purpose of giving him something of money value. The government had inherited from England a continent of natural resources. In the minds of the people the government existed primarily to distribute public lands, to give away farms, to give away mines, to give away corporate privileges. All of the interests which dominated our political society were organized on the theory of getting something out of the government for little or nothing, — something which would contribute to private gain. The organization of corporations to obtain subsidies and privileges, the formation of political parties for spoils and private appeals for personal advantage to be obtained through "pull" were simply ways of getting it. At the present time citizenship in the United States has begun to take a new view of the situation. Amer-

ican citizenship has awakened to the fact that there are few of these large and valuable Christmas presents to be handed out each year. Our public lands have become private lands. Our people are now going to Canada for free homesteads, preëmption rights and so on. They used to go to Canada for other reasons. Public franchises have largely been converted into private proprietorships. As a people, we have suddenly awakened to the thought that this splendid indifference to the value of our national inheritance as a public resource has been a mistake; that private ownership in many instances means monopoly, — we call it vicious monopoly when some one person or corporation owns more than is ordinarily held or owned by a single man. I do not mean to suggest that there is anything in private ownership to be feared, but there has been something in the attitude of the public mind which necessarily must change. Now that all of the things that the government can give away have been exhausted, we have suddenly awakened to the fact that 99 per cent of us need protection against the other 1 per cent; that the government is the only organization capable of affording the protection needed without a popular uprising which would disturb all of the conditions essential to social progress and coöperative activity. We are beginning to appreciate what a welfare institution means and what its functions should be. We are beginning to see that the government has some purpose, and that *laissez faire* should no longer dominate our politics. With this situation present, with public opinion suddenly converted to the notion that the government should do something instead of doing nothing (except give away property); with the assembling of vast populations in centers where the individual, from his relative impotence, becomes the victim of social neglect unless the government steps in to protect him; with an environment which makes the individual the easy victim of contagious and communicable diseases, of accidents and other disasters incident to living in crowded centers; the American people have begun to see that their government is the one institution on which they

must rely. This idea being paramount in the minds of the people, every party — we may say it is a non-partizan notion — demands of the government efficiency; demands economy that will not permit of the waste of public funds entrusted to officers for your protection and for mine; demands that proper use be made of the properties and equipment which have been procured with public funds for the purpose of conserving health or for promoting education, the maintenance of law and order, for providing people with transportation and other facilities essential to the common welfare. With this idea paramount in the minds of the people, it seems to me that we have an outlook quite different from any which we have had before, and that this outlook is in the direction of the interests which we may call general welfare as distinct from those interests which are private or personal in character.

What are we going to do about it? We are going to use the instruments which have been found useful in private business for accomplishing these ends. We are not only going to plan the work of the institution in relation to the society which it serves, but we are also going to plan each step in the execution of the plan. In other words, we shall have a planning executive as well as a planning legislature, and we shall have an intelligent executive as well as an intelligent legislature, because the government will be premised on the planning of an intelligent people. That is what I think we must look forward to, and may look forward to with confidence. In planning our scheme of government, we must think, not of the state of New Hampshire, or of the village of Hanover, because the governing of the citizen of Hanover is the governing of this town plus that of the state, plus that of the United States. Our plan of business is a threefold, corporate plan; at least threefold,—sometimes twentyfold; each one of these corporations having been organized to take a part in the business which we consider essential for our welfare. In considering, therefore, our plans and policies, we must necessarily know what the government of the United States

is doing for the citizen of Hanover, what the state of New Hampshire is doing for the citizen of Hanover, in order to decide what the precinct commissioners should do for the citizen of Hanover. We must not only see our public business as a comprehensive scheme, but we must have the means of knowing what is being done, and to an extent what has been done. In other words, it is the same problem as is before the stockholder of the corporation, who a few years ago awakened to the fact that he had interests to protect. We have had the various investigations looking towards better administration of life insurance, better administration of railroads, better administration of banks, better administration of every kind of quasi-public corporation as well as private corporation. We shall simply have to apply the same principles to our public corporation that we have applied to our quasi-public and private enterprises.

QUESTION: I should like to ask Dr. Cleveland what steps should be taken to put this information in the hands of the executives and the people; whether these steps should be taken by the citizens or by those elected to office?

MR. CLEVELAND: It seems to me, Mr. Chairman, that primarily those who are in position to develop information are those who have the instruments for collecting, recording, summarizing and reporting information; in other words, the instruments of accounting which bring together facts, coördinate facts and present facts in such form that their significance can be understood. Perhaps the questioner has in mind some of those enterprises with which I have been associated during the last few years. During the last few years I have been closely associated with a number of citizen organizations. And I speak of this simply to illustrate a point which the questioner evidently had in mind — what can the citizen do? In organizing the Bureau of Municipal Research in New York and also that in Philadelphia, these two agencies being supported by private funds, the theory was this: that the existing agencies of citizenship (and there are many of them, — some 2,000 of various kinds in Philadel-

phia alone) have not been developed for the primary purpose of making the citizen more effective in his relation to the government. The fact is that nearly every other kind of public interest has been made the subject of organization, but that practically all of the activities of the government as such have been left out of consideration. In other words, each of these societies has a highly specialized theme, such as the administration of private charity, the promotion of education and morals, the welfare of immigrants, etc. Each of these is interested incidentally in what the government is doing with respect to its particular cause, but not to the extent of finding out what are the methods and processes employed, and whether the service might do it more economically and efficiently.

Certain clubs have been organized, called city clubs, which have a broad outlook. Each has attempted to consider the work of its city as a whole, each has organized many committees for the consideration of special subjects, but not one of these organizations, so far as I am aware, has ever organized or provided itself with the means for obtaining information about technical processes. Those of you who are engaged in business know that exact knowledge of details is the only safe basis for judgment. Notwithstanding the fact that our public corporations have the most involved, complex and technical business problems which may be found, citizens have assumed that they could get together and by the exchange of opinions about the duties of citizenship and other subjects which are highly theoretical and philosophical, — that by some such methods the problem of community business may be solved. The action and attitude of the average city club is about as helpful to the officer who is charged with responsibility for the management of the city as would be a meeting of citizens who would come together at a dinner and pass resolutions concerning the management of the Pennsylvania Railroad. In the very nature of things, those who participate in such touch-and-go proceedings cannot have knowledge about the management of a city or of a railroad;

neither can citizens who get together and pass resolutions about the government take up any matter intelligently, unless they have provided themselves with some agency by means of which the technical problem may be studied.

Having participated in the work of many such committees, having become conscious of the ignorance with which subjects of public concern are approached and having come to know the damage which is often done to a good cause by unintelligent citizen action; the conclusion was reached by a few men in New York that citizenship could not hope to become effective in the exercise of its sovereign powers until citizen duty and governmental responsibility should become subjects of inquiry; until organized means should be provided for knowing definitely what are the needs of the community which should be served by the government; what the government is doing to meet these ends; what is its organization; what the conditions surrounding its personnel; what the technical processes employed; what the results being obtained. In other words, it was thought that as a matter of duty, citizenship should provide for itself the same kind of an organization for house-cleaning as did the life insurance companies at the time they were under legislative investigation.

Every citizen of the United States has a right of access to public records. Every citizen, therefore, has a right to inform himself and to use the information obtained from records for the information of his fellows. But the trouble is this: that even though a particular citizen has free access and gives all of his time to the consideration of questions of citizen duty, the government is so highly complex in organization and technical in requirements that he will do well if he comes to understand one of its problems in such manner that he can think about it with intelligence. This is a condition which must be faced. If citizenship is to be effective, citizens must use their power of independent inquiry; but they must organize for using it. It has been upon such a theory that bureaus of municipal research have been organized and supported. The fundamental or charter rights of such organizations are:

1. The right of access to such records.
2. The right of free speech and free press.
3. The duty which a citizen organization has to support the hands of the officer, — to stand back of the man who wishes to do what is right, and in front of the man who wishes to do what is wrong.

The government agent should be called upon to produce such information as may be currently or regularly reported. He should be called upon to furnish this not only to the executive officer and to the legislature, but also to the citizen; the administration should be called upon to lay before the legislature and the people a definite program to be financed, and the legislature should be held responsible for the way in which it acts on such a program. This information should be supplemented by statements of fact showing records of performance and results which may be appraised in terms of standards based on concepts of welfare. Alongside of an official agency should be an agency of citizenship which will be equipped for going into each technical subject concerning which detail data may be desired, and which will enable the citizen body, without partizan cant or the warp of private interest, to sit in judgment on the acts of their trustees who have been appointed or elected to places of official responsibility. This to my mind is the answer to the question, "What steps should be taken to put information into the hands of executives and into the hands of the people?"

# Sixth Session

SATURDAY FORENOON, OCTOBER THE FOURTEENTH

CHAIRMAN, MORRIS LLEWELLYN COOKE
*Consulting Engineer, Philadelphia*

# PHASES OF SCIENTIFIC MANAGEMENT: A SYMPOSIUM

## CHAIRMAN, MORRIS LLEWELLYN COOKE

LADIES AND GENTLEMEN:

THE idea back of this meeting is to make it a series of practical illustrations of the application of Scientific Management, rather than a theoretical discussion. For this session several speakers have been asked to speak from ten to fifteen minutes on some one problem each has encountered in his practice; to state the problem and show the way it was worked out. In other words, what we are to hear this morning is research work that has shown results. This is an experience meeting.

I will call first on Mr. H. K. Hathaway, the vice-president of the Tabor Manufacturing Company, Philadelphia, a consulting engineer, and one of Mr. Taylor's closest associates.

MR. HATHAWAY: At the Tabor Manufacturing Company we have succeeded through the application of the Taylor principles of Scientific Management in increasing our production to about three times what it formerly was, with the total cost approximately the same and approximately the same total of men; of course with a very much smaller proportion of the men in the shop, and a much increased proportion of men in the planning department, or on the management side. When I first went there we had one superintendent who had a foreman in the shop, and I think there were two clerks. At that time there were about 125 workmen. Now, in normally busy times, we have something like twenty-five functional foremen and clerks in the planning department;

what might be called "non-producers," if that name were still in vogue, — Mr. Barth forbade us all yesterday ever to use it again. In the shop we have probably about seventy or seventy-five workmen actually doing the work, yet we are turning out about three times the total product we formerly did, measured in dollars and cents. That has been made possible, not by a few large savings, but by innumerable small savings in time.

About the most remarkable single case that I know of is on the assembling floor. In the assembling department of the Tabor plant, at the time we started to install the system, we had eleven men acting as erectors, putting up machinery, and they assembled about nineteen machines a month on an average. Now we have six men, and they assemble between sixty and seventy machines per month.

It might be interesting to know to what that is due. Under the old scheme, the assemblers were assigned their jobs by the foreman. An assembler would come up to the foreman and want to know what he should do, and the foreman, after looking around, would decide that he might as well start assembling a machine, or a lot of machines. Apparently the materials were all on hand. There were at least enough of the larger parts so that it looked as if he had enough to start on. The man would start to assemble the machines. He would progress to a certain point and find some small part missing without which he could not proceed with his work. That, of course, would necessitate his hunting around to find where that part was. In a good many cases he would wait. He would go to the machine-shop and inquire from one man to another until he finally found whether it had been made or not. If it hadn't been made, he frequently would wait until it was, keeping out of the way of the boss until he could proceed with his work. So about as much time was spent, under the old scheme, in hunting up the materials and waiting for materials, as there was in actually doing the work. Another source of delay at that time was that a man would start to assemble certain parts, put them together, and find that

they wouldn't go together. That would necessitate his chipping, filing and scraping, until he finally could make them go together; in other words, correcting errors of the drafting department and of the machine-shop. Such conditions do not exist under the new scheme. A man is never started doing assembling work until we are sure he has all of the materials on hand which are required to complete the assembling operations assigned to him. The parts, as they are delivered from the machine-shop, are placed in certain racks or bins. The parts from the stores are delivered at the proper time, and when all of the parts which enter into a certain group of the machine, or the entire machine if it is a simple one, are ready, we issue an order for one of the assembling men to perform certain specific operations. In that way, we eliminate the time wasted in hunting around for material for the job. We get away from the chipping and fitting and filing, formerly necessary to make things go together, through an adequate scheme of inspection. There is no question in the mind of the man doing the machine-work what the requirements are. As soon as the job is on the machine the inspector goes there and instructs the man as to the degree of accuracy required, the kind of finish and any other matters pertaining to the quality.

When the job has been finished, the inspector goes there again and inspects every piece in the lot, with respect to that operation, to see that no errors have been made. If there have been, they are at once reported and corrected, before the material arrives on the assembling floor. Formerly, they were not corrected, and were not discovered until the material arrived on the assembling floor. It is the case in many shops today, even comparatively well-run shops, that errors are not discovered until the material has reached the point where it is to be used. By eliminating those two sources of trouble, and by doing certain things to assist the workman, such as having the materials placed on his bench, or on the floor for him in advance, and having his drawings and his instructions delivered to him in advance, we have

been able to increase the output of the assemblers from less than two machines per man per month to nine machines per man per month. That is probably, as I say, the most remarkable thing in the Tabor Company. However, there are various places throughout the shop, in the machine-shop for instance, where a man is producing from his machine as high as five times the amount of work that he formerly produced, and *without any greater effort.* The selection of the man for the job has also resulted in considerable savings, and has contributed to the results achieved in the instance I have been citing.

Another thing I might mention. We have a certain machine which we build in considerable quantities. It is one of the few jobs we have that we call a "standard job," something that we are manufacturing continuously; and of the main casting, which we call the base casting of these machines, in our shop the boring-mill man turns out ten per day. About a year ago we fell behind our orders on that particular type of machine, and it was necessary that we do something to get ahead; something more than we could possibly do in our own shop. So we got two or three outside shops to estimate on boring a lot of those bases for us. The prices quoted were prohibitive. What was more important than that, the best we could get any outside shop to agree to do was to finish two of those bases per day. In our shop, a man finishes ten per day. Well, two per day wouldn't help us at all; would not bring them fast enough. So we finally got hold of one of the parties who quoted on making them, a personal friend of mine, and I asked him if he would allow us to use the boring-mill he had in his shop, sending our own men to operate it and our own tools, and he agreed to that. The machine which he had was an old machine, rather light, and had only one head that could be used. The machine we were doing them on, turning out ten per day, was a heavier machine, having two heads that could be used together. However, we sent our man over to their shop. He was a man at that time acting as an

inspector, but who had formerly run the boring-mill in our shop. He was thoroughly familiar with the job. We sent him over to their shop, and he spent about eight hours, as he expressed it, "digging the machine out of the dirt"; cleaning it up, and getting it in shape so that it worked properly; seeing that the slides worked freely, and so on. He took his own supply of bolts, clamps, cutting tools and everything needed to get his job set up and started on the machine. The first thing he found was that the belt was loose. He had suspected it was, but he found as soon as he put the work on, that it was very much looser than he thought. So he took his hammer and chisel and cut four inches out of the belt before starting to do his job. To make a long story short, that workman went into the shop of my friend and standardized conditions as far as that particular machine was concerned. It is exactly what we do for an entire shop, where we are installing the Taylor system. This workman went through and standardized the conditions, as far as it was possible for him to do so, at that particular machine. The result was that he succeeded in turning out eight of those castings per day, on an inferior machine, in another shop, where the best that the parties were willing to do, or would undertake to do, was to turn out two per day. The people in the shop where this was done were simply amazed to see the work being turned out so rapidly.

There are innumerable instances of that sort which might be cited, but they are so very numerous that it is hard to pick out single cases. I think possibly those two cases are enough.

THE CHAIRMAN: There are three different kinds of time-study; fake time-study, the kind that ordinary mortals make, and the kind that Mr. Sanford E. Thompson makes. Whenever any of us has a really fine piece of work in time-study to do, he always tries to get Mr. Thompson to do it. Mr. Thompson is one of those men who can cover a good deal of ground, and he doesn't confine himself to making time-studies. I think he is going to tell us this morning some-

thing about the application of the scientific method of routing in building construction. Mr. Thompson.

Mr. Thompson: As our Chairman has said, one of the matters which I have been interested in lately is the organization of construction work. The construction man will tell you that Scientific Management is all right in the shop, but it does not apply in the field. He will say that in the shop there is regular help which stays from year to year; there are machines which can be standardized; there are routes which can be fixed and kept; there are the same operations over and over again. The contractor will say that on two jobs he has scarcely ever the same workmen; that the conditions of two jobs are never alike; that the weather conditions affect the work; and that there are a great many other variables which so change conditions that it is absolutely impossible to systematize. I know that most of the men before me are interested in manufacturing, but instead of taking up the application of time-study in manufacturing, to which Mr. Cooke has referred, I want to illustrate how completely the fundamental principles of Scientific Management, so far as I have gone with them, apply to work of widely different types: and not merely the principles, but the methods and the apparatus. One of the most poorly organized classes of work in construction is the building of reinforced concrete buildings. I think there is not any kind of construction work where more money is lost by inexperienced contractors. It requires long experience for a contractor to learn how to estimate the cost of a concrete building and then keep within his estimate. One of the parts of the construction of reinforced concrete buildings which is especially unsystematized is the building of the forms. As you know, before a concrete building is started, — that is, before the concrete is put in — wooden forms or molds the shape of the columns, or of the beams, or of the slabs, have to be made, into which the concrete in an almost liquid condition can be poured, to take the shape of the finished building. These wooden forms are made up by carpenters. They are made up in

sections; the side of a column, the side of a beam, the bottom of the beam, and so on. The carpenters work on benches in making up these sections. The ordinary method of form construction, unsystematized as Mr. Kendall would call it, consists in ordering enough lumber for the job in random lengths and random widths and piling it in the yard wherever there happens to be a good place for it. Then the foreman takes the general plan of the buildings, — not the form plan, he doesn't have any form plan — he takes the general plan of the building, and ascertains the length of the beams between the supports, and the height of the columns from floor to floor, and he figures out the length and the width that the forms should be. Then he takes a carpenter, and he tells him, "Now, I want you to make twenty-five like this," and he lays it out in a way on his bench, so that the carpenter will make them up right. The carpenter goes to the pile of lumber that happens to be the nearest, and selects material from that pile. Sometimes for the same form he may have three eight-inch boards, sometimes four sixes, or whatever happens to come to his hand, and he takes them, puts them on the bench and makes up his forms.

Now suppose we take the new plan, approximating to the conditions one would have under Scientific Management in a shop. The forms are sketched out in the drafting room; sketches are made for every form, showing the pieces of lumber that go in that form. Then the lumber is ordered in lengths and widths which correspond most nearly to the sizes. It is impracticable, usually, to order the exact widths and lengths, on account of sawmill conditions. When this lumber comes it is piled in a definite place, and according to width and length. With bulletin boards, just like the bulletin boards in the shop, we have move-orders — little slips — to move the lumber from the piles to the job sawmill. They are like the time-cards which are used in the shop. A duplicate of this move-order goes to the sawmill man, and he saws the lumber. Then another set of orders, a move-order and a make-up order as we might call it, is issued, and the lumber

is moved by laborers (carpenters don't carry the lumber now) to the place where the carpenters are to make up the forms on the bench. All the carpenters then have to do is to take these sketches and make one form after another, according to the directions given them. These directions are based on time-studies, — I cannot get away without some remarks on time-study, although I am not going into it very deeply. The time-studies for the task-work on the forms are made on just the same general principles as the time-studies for the shop, and have the same result in economy. Under ordinary conditions of form construction for concrete work, a contractor has to guess how many carpenters and how much time it will take to make the forms for a particular job. The forms for no two jobs are the same, and the records of the construction of forms for one contract do not give exact enough information to permit more than a guess concerning the construction of forms for another contract. But although no two forms are alike, the elementary processes which go to make up the construction of a form, — putting a board on a bench, laying a cleat on the boards and driving a nail — are the same in the construction of all forms; the difference is in their combination. Now Scientific Management, in this matter of making forms, makes a time-study of the operation of laying a board on a bench; another time-study of the operation of laying a cleat on the boards; and another time-study of the driving of a nail. With that information a contractor can determine how long a time and how many men it will take to make any number of forms for any job, and he can set tasks. Suppose he has an eighteen-foot form to make, a size he has never made before. He can tell exactly how long it will take. He knows how many boards are to be laid on the bench and how long it takes to lay each there; how many cleats to lay on the boards and how long to place each one; how many nails to drive and how long to drive each. This presupposes, of course, that boards, cleats and nails are piled in a given place and are of the proper size, and of this Scientific Management takes care.

In the routing of this material, I have spoken of the irregular work that is usually done in connection with form construction. I have found that the cost in making up forms, even without task-work, in some cases has been reduced about one-half, simply by planning the work and systematizing the handling of the materials; doing of laborers' work by laborers instead of by carpenters. Of course, there is a further reduction in cost with task-work.

I spoke at the beginning of criticisms made and objections raised to Scientific Management in the field. It is almost laughable, the way any man who is contemplating Scientific Management, or has had it first called to his attention, will make the same remark as another man, that "it is applicable in your shop, but it cannot be done in my shop, because my conditions are entirely different, and too intricate." Of course, the answer is that Scientific Management has been and is being introduced in a variety of shops, in cotton-mills, in dye-works, in machine-shops, in pulp-mills, and so on. Take the machine-shop conditions, for example, and take the out-of-door conditions, and notice that we can use, as I have said, the same methods, the same blanks. We use route-sheets, just the same as we do in the shop, to lay out the work. We were unable on one job to get our route-sheets in time. I telephoned over to the Plimpton Press and asked them if they would loan us some route-sheets. They did, and we used those route-sheets of a printing and binding plant successfully in the work of form building.

The Chairman: I see no reason why anybody in the audience who wants to question the speakers should not do so. We do not want to spend an undue amount of time on that.

Mr. Webster: I should like to ask Mr. Thompson whether it is true that a carpenter, scientific or otherwise, will drive nails at the same rate on a long job as on a short job.

Mr. Thompson: There will be but little difference provided each is part of a full day's work. Of course, a single nail will take less time in proportion than fifty nails, because of

lost time and delays that will occur throughout the day. For this reason a percentage must be added even to the average times of individual units when combining them. It is surprising how uniform the percentage will be. In bricklaying, for instance, take the time the average bricklayer requires to lay one brick and the time of stretching the line and the time he takes to strike off the joint, and you will find, when combining these unit average times, that 30 per cent must be added to allow for rest and delays. This will figure out the same time after time on average work.

Mr. Webster: You say it takes practically the same time for a fourteen-foot board as for a twenty-foot board. Would it be the same for a fifty-foot board?

Mr. Thompson: Different sizes of boards may require different times, but with the only one variable like that it is a simple matter to study a few sizes and then by interpolation or by curves to obtain the times on intermediate sizes. For example, take the average time for a ten-foot board, a twenty-foot board and a thirty-foot board and you can plot a curve upon which you can locate the time of any length you have to handle.

Mr. Eaton: This is a matter of vital interest to me. I had this little experience. I went to the Jersey City piers of the —— boat and started to measure with a stop-watch one of the gangs in the flour pier. On the spur of the bonus some did special work and worked harder than others. I had one particularly bright Irishman who worked one day at a maximum and didn't show up for seven days after. I should like to ask how we can find the average skill which permits the men to do a maximum amount of work, take their rest and do their work again. How would you do it? Should we study for one month or for six months? I understand from Mr. Taylor's theory that you must find the average at which a man can normally and easily work.

The Chairman: I think, from what I gather by your remarks, that the conditions were not properly standardized. In other words, you were doing business with human nature

rather than with physiological conditions. I happen to know that one of the gentlemen who are going to speak will give a suggestion which, I think, may satisfy you. I am going to call on a man who has been with Scientific Management perhaps as long as anybody, except Mr. Taylor; and I always think of him as representing the best of Scientific Management: Mr. Carl G. Barth.

Mr. Barth: As I understand it, each of us is this morning to recite an example of some of the peculiar circumstances and difficulties we sometimes meet with in our work of improving the machinery or other conditions in the industries we undertake to systematize. Perhaps one of the most important things I personally do in the machine-shops I tackle, is the rebuilding of old machines so as to make them fit to utilize modern high-speed cutting tools; and I happen to think of one instance of this kind which particularly gave me a great deal of satisfaction.

Two ordinary milling-machines had each been very cleverly converted into multiple automatic gear-cutting machines for certain special gears, in such a way that six gears were placed, in pairs, on each of three dividing spindles, and simultaneously cut by each of three cutters mounted on a common arbor; and at the time this had been done, these two machines were comfortably able to keep up with the rest of the production of the shop. However, as the production was materially increased some time after I was called into this shop, these machines frequently had to be run overtime — they being the ones most behind in production. As a consequence, I took up the consideration of how this production might be increased without the addition of more machines, which was just the kind of a problem especially up to me, as I was engaged for the purpose of increasing the output of the shop as a whole without the addition of new machinery.

Taking the matter up with the shop superintendent, who was personally responsible for these gear-cutting machines as they were then running, he at once informed me that nothing could be done to further increase their production,

as he had already tried everything possible in an effort to do so. Yes; he had now in the tool-room six high-speed cutters, bought from the Brown & Sharpe Mfg. Co., which he had tried out, and he had found that he could not get more out of them than of the carbon cutters, as the machines themselves could not "stand" any more than the carbon cutters could.

The minute he expressed himself in this way I knew that he had not known how to go about the matter, and insisted that we at once demonstrate what those high-speed cutters would do on the same material when run on a single pair of gears in a large milling-machine of ample stiffness, and provided with a number of speed and feed changes. In doing this, we ran one of these cutters for several hours at a rate fifteen times higher than the rate at which the carbon cutters were running in the gear-cutting machines referred to. This was an eye-opener to everybody concerned, and it was fully agreed that I was right in saying that, unless it were possible in some way or other to utilize these high-speed cutters on the present gear-cutting machines, they ought to be discarded and new, up-to-date machines secured.

However, I did not hesitate to guarantee to quadruple the output of the old machines, which would put them far ahead of any possible demand upon them. This at once got the superintendent at my ears; for in the first place he did not believe I could do it, and secondly, he did not wish to see me succeed where he had failed.

In the meanwhile I had fully realized the reason for his failure as soon as I had been shown the high-speed cutters, which were of the standard size for that pitch, with only a seven-eighths-inch bore. The reason why no more could be done with these than with the carbon cutters on the gear-cutting machines mentioned, was that the limit was the lack of stiffness on the part of the long arbor of only seven-eighths-inch diameter, and not on the machine itself; though this was not as stiff as desirable, and was therefore also readily set into vibration by the vibrations and chatter of the flimsy arbor.

I therefore secured new high-speed cutters with a one-and three-fourths-inch bore, and with the key-seat cut in exactly the same relation to the teeth on all of them; and also had a suitable arbor made with the three keys for driving the cutters, so staggered on the circumference that the teeth of the three cutters would not strike the face of the gears at the same time in starting in, but would do so in succession.

I also quadrupled the only feed on one of the machines, but left the two speeds — of which one was double the other — as they were, with the idea that some experimentation might be necessary before we could get the best out of these.

However, as we found it possible to run on the higher of these speeds, whereas before they had been running on the lower, and we thus, all told, attained an eight times greater rate of cutting than before, with the ability to cut this in two if we ever would encounter extra hard castings, I was satisfied to leave the speeds as they were.

The eight times higher rate of cutting, — coupled with the time required to take the six finished gears off the machine and put on six new blanks — resulted in a new production of six gears every thirty minutes, as against the old production of six gears every two hours and thirty minutes, or five to one, as against the four to one I had guaranteed to get.

I look upon this as a good example of what may be done by a full analysis of a difficulty encountered, and also of the jealousy we sometimes meet with when fearlessly and steadfastly pursuing our work and carrying out our convictions; as exposed by what occurred after both machines had for several months been turning out gears at the new rate whenever they were required to run, though they were now necessarily often shut down for lack of work.

The first batch of extra hard gear-blanks encountered were not properly looked after, and as a consequence a set of cutters was badly burnt before the fact was realized by the rather ignorant attendant, and for the rest of this batch the machines were put down on the lower speed, — a matter we, as before stated, had anticipated might at times be necessary.

This incident was so perverted, however, in spreading to other departments of the large factory, that some jealous individual who had evidently all along been watching for an opportunity to belittle our work, wrote to the general superintendent informing him that our claim that we were doing so much better with our gear-cutting than formerly was all idle boast, for he had ascertained that we were doing only 30 per cent more than formerly, and in so doing used far more expensive cutters, and even then had to grind these more frequently than the old cutters.

This led to an investigation and a report by me in which all the facts were ascertained and set forth, along with the statement that if we ran the machines at all as now refeeded, we could not do the machine-work at a lesser rate than four times the former rate, and that thus the 30 per cent production had absolutely no foundation; while the alleged frequent regrinding of the new and more expensive cutters was simply the exaggeration of a single incident exceptional to a general condition.

The Chairman: I want to say that when we began this morning we decided we would make this simply an experience meeting in which each speaker in ten minutes would state a problem and the way he had solved it. I want to know whether Congressman Redfield won't give us an experience of that kind.

Honorable Mr. Redfield: I do not come here because I am a Congressman but in spite of it. I am a manufacturer and have been for twenty-six years. I am glad to tell you certain actual experiences in the shop along the line of some of the ideas suggested here, which we had adopted at our shop without knowing they were scientific. That was because we didn't know enough. The greatest curse the American manufacturer has is knowing his own business. It is a disease of the brain. I speak from having sold goods made in America in every civilized country in the world, personally, and in most uncivilized ones; and I tell you right here, gentlemen, there isn't any reason in the world why you can't

sell goods in Birmingham, Paris, Berlin, Vienna, Tokio or anywhere else just as well as you can in New York and New England. I have done it. I have been in a Japanese textile mill and had the proprietor tell me he used four times as much help per yard of cloth as is used in New England. Yet the New England mill was way ahead in quality of production, but its manager knew his own business and that was the trouble. Years ago a very successful partner, an older man than I and wiser, laid down this rule to me as his junior — I commend it to you — "Every manufacturer should always and continuously be his own severest critic. He should always be finding fault with himself. He should never be satisfied, and he should never let his business get into such a condition that any customer can find fault with him. That shows he doesn't know his job. At the end of twenty years of practice I begin to realize that I know very little about this business." Long years ago he said to me, "Redfield, you are not in the factory end of this thing, you are in the outside end. For that reason please take an hour every day and go out into the shop and find all the fault you can." I did, and for ten years, gentlemen, I never went into my shop without finding something wrong. I lay to that simple fact the other fact that from the smallest of eight concerns it grew to be the biggest of forty. To the man who says to me, "I know my own business," I say in my own mind, "God help you."

Now, gentlemen, I saw the output of the shop doubled in three years without adding a man or a machine. I have seen the product go from 2,800 per day to 11,000 per day. How was it done? In one single way above all, — by the constant spirit of dissatisfaction with oneself, by the constant determination not to be satisfied, and above all things by never thinking, "Now I am right." I have seen in ten years the entire reconstruction of the machinery in the plant three times; three times the practical scrapping of the whole plant as it grew, not in a chunk but in items. I am going into a little detail with a drop-hammer. It began with a base which

weighed six times the weight of the arm; both were cast iron, the uprights were in anthracite cast iron, the bearings were babbitted, the shafts were a soft steel forging and the rollers were riveted. The arms were iron. At the end of ten years that has twice been completely redesigned. The base now weighs fifteen times the weight of the arm, the arm has become a steel forging made in heavy steel and the uprights have come to be made of charcoal iron like a car wheel; the shaft is an inch and a half in diameter and made of forged crucible steel; the bearings have become bronze, and the rollers are steel castings with polished surfaces. The guide-rods which operate the rollers above are made of hammered iron casting, — seven cents a pound in the rough — and tipped at the bottom with steel casting, — fifteen cents a pound — which an expert blacksmith had learned to weld on to that iron. In other words, that machine has been refined until the product is three or four times what it was before, and what is more important, the element of repairs has practically ceased to be.

Now, another thing we said to our men, "Your piece-rate shall never be cut, no matter what you earn." When that thing happened (my partner did it), he called the superintendent upstairs and told him what he was going to do. The superintendent said, "Some of these men will earn too much; they will earn \$7 or \$8 a day." "Well," said my partner, "is your salary too large?" He said, "That is different," and my partner asked, "Why?" And the superintendent withered up and was silent. We agreed that obvious mistakes should be corrected, but only by mutual consent. We abandoned absolutely the principle that we had a moral right to cut a rate which we had made. I tell you, gentlemen, if I say nothing else here at all, that to cut the piece-work rate because a man is earning a large salary is a moral wrong and an economic mistake. From practical experience I tell you the labor men are absolutely right in regarding such a thing as a curse to them and as a crime against the interests of the manufacturer, and yet I have a

friend who boasted to me that he cut his piece-work rate five times on one single job. I think he should be locked up.

Our men knew that their piece-work rate would never be cut, never so long as we lived, at least, and that whenever a machine stopped, it cost them money as well as us. The consequence was that the machines didn't stop. The men would come in fifteen minutes before the time, to look over their machines; look over them, under them, everywhere, and if there was the slightest thing wrong they would run for the repair man to get that machine going. I won't tell you what happened to the repair man, because I don't like to tell the number of thousands of dollars that went out from day to day. It was far more than the wages, and it had no relation to the doubling of the output. Furthermore, when the men knew we were dealing with them in that way, they began to be willing to remake all the spoiled goods in their own time, and finally they paid for the material they used in making spoiled goods, voluntarily, and saved more than $10,000 per annum.

A Swedish manufacturer once asked me when I was selling goods against him at a place only fourteen miles away from his plant in Copenhagen, "How can you pay so much? We pay $2.25, or nine English shillings, and we work fourteen hours. What do your men earn?" I replied, "An average of $5 and they work nine hours." He asked, "How can you do it?" I said, "That is the reason." I am perfectly serious about it; that is the reason. I went on to tell him that when his men got so efficient and his plant so perfect that his men could earn $5 in nine hours, then I would begin to be afraid of him, but not until then. I know these things are not accepted; some of you gentlemen are saying in the corners of your minds, "Not in my business." I know that habit perfectly well. I have had 2,000 manufacturers for customers through these years in every country in the world. But it is the Lord's truth, and the sooner you get to know it, the better for you and yours. There are three interests in your factories,—yours, your workmens',

your customers'. You cannot run your shop in your own way and ignore the workmen and the buyers. The workers cannot work and ignore you and the buyers. Nor can the buyers ignore you and the workmen and say, "You shall do thus and so for me." The three have to get along together. Isn't it about time we got big enough to discard the prejudices of the past and try to pull together, not separately?

THE CHAIRMAN: We have all been watching the quiet work of one individual who has been working along lines apparently absolutely different from those being followed by any other worker in the Scientific Management field. I wonder if Mrs. Gilbreth would say a word to us.

MRS. GILBRETH: I did not expect to speak in this place, but I feel as though I must. There is something I wanted very much to say at the meeting on academic efficiency yesterday, but there wasn't the time. I feel that the gap between the problems of academic efficiency and industrial efficiency, which is after all only an apparent gap, can be easily closed if only we will consider the importance of the psychology of management. I spent several years examining and studying it, and it seems to me that Scientific Management as laid down by Mr. Taylor conforms absolutely with psychology. Principles of vocational guidance may be studied along psychological lines to train the individual so he will know exactly what he does want to do. It is the place of the colleges to train the man so that when he comes into his work there will be no jar. Since the underlying aim is the same, and since psychology is the method by which we are all getting there, isn't it merely a question of difference of vocabulary between academic work and scientific work? Why not bridge this gap and all go ahead together?

THE CHAIRMAN: I always sympathize with a man who has to buck up against really hard problems, and I think Mr. Gilbreth has those all the time on his construction work. Mr. Gilbreth is vice-president of the Society for Promoting Engineering Education, and for these two reasons I think we should be very glad to hear from him.

Mr. Gilbreth: I propose to tell you two simple stories of things in line with what the others have told you this morning, except that perhaps they have this difference; that in our work things happen suddenly, something like a fire, and we have to be ready to work instantly. When I first read Mr. Taylor's papers I said, "Mr. Taylor, that is the finest thing I have read in my life, and I am sorry I can't adapt all of it to my business. Of course there are some very nice things that perhaps I can adapt, but it is unfortunate that your work is so different from mine that I simply can't apply much of it. I realize that that is the finest way in the world to run a machine-shop, but my work is different." Mr. Taylor was very patient and said, "If you will keep on trying you will find that it is right." I can save you gentlemen a lot of time if you will think that over.

Take Paper No. 1003, by Mr. Taylor, one of the papers of the *Transactions of the American Society of Mechanical Engineers*, called "Shop Management."[1] After you have read that through four times at least, then get some of the other publications, notably papers No. 647[2] and No. 928,[3] the former being the first paper that Mr. Taylor wrote. The criticism has been made that "he shot over the head of the average man." But if you will read the other one, Paper 1003, you will find it is a little nearer the level of the average man. Then read his presidential address, recognized everywhere as the greatest paper ever written on the subject, entitled "The Art of Cutting Metals."[4] Although that paper is so good, people unfortunately do not know what it is about. They are misled by the title and don't understand that it is really about management. It made such an international row on the subject of cutting metals, — I heard of it again last summer in England — that they refused to discuss what he had to say on the subject of management in it.

[1] Vol. xxii, p. 1337.
[2] "Piece Rate System," by Frederick W. Taylor, Vol. xvi, p. 856.
[3] "Bonus System for Rewarding Labor," by Henry L. Gantt, Vol. xxiii, p. 34.
[4] No. 1119, Vol. xxviii, p. 31.

It is not about metals at all, it is about management. After you have read Paper No. 1003, then No. 647, then "The Art of Cutting Metals," then No. 928, then Paper, — I don't remember the number, by Carl G. Barth, on "Slide Rules as a Part of the Taylor System of Management,"[1] you will find that nearly all of the questions you ask are answered in every one of these papers.

Yesterday I had the pleasure of listening to the professors discussing academic efficiency and they asked a great many questions. I felt sorry for them because I have asked these questions so many times myself; but there is no excuse for my continuing to ask questions, — they are all answered in "Shop Management," No. 1003.

Now one thing about the discussion of academic efficiency. I am building a fairly large job at the present time on which I have a number of high school graduates, and a number of young college men, most of them from a few months to a very few years out of college. They come from the best colleges in this country, and they have formed themselves, without any suggestion from anybody, into the first Canadian Society for the Promotion of Scientific Management. They used as one of their books Bulletin No. 5 of the Carnegie Foundation, written by our chairman of today, and from their standpoint the management as described in that bulletin is flawless. They have told me so as I have talked with each one of them. Now the question of academic efficiency I am not prepared to debate, but I will say this however; these young men came from different colleges, the University of Illinois, Yale, Brown, Lehigh, Massachusetts Institute of Technology, and I don't remember what other colleges, and every one of them said, "I regret exceedingly that our professors have not taken this thing seriously, and given it to us while we were in school." I pass this on to you.

Now I am going to give you a very simple case that happened all of a sudden. Unexpectedly we found ourselves possessed of a contract to unload a barge and deliver the

[1] No. 1010, Vol. xxv, p. 49.

material near a job. The road from the wharf ran up and around the shoulder of a hill to the site of the job. The way they had to unload that barge was to back up the teams to the boat, and then drive up-hill and around to the job. The material had to be unloaded somewhere in that circle until they were ready to use it. Before we got there, this being an emergency piece of work, they put the best foreman, as good a foreman as you could wish to see, in charge of this work on the old-time plan. Mr. Kendall called it yesterday the "unsystematized plan." We call it the "traditional plan," and if there is a little improvement in the traditional plan we call it the "transitory plan," and if it is down to what Mr. Taylor means when he calls it the "ultimate plan," we call it the ultimate plan.

Now you can readily understand that a fire department can have the ultimate plan of management even though it doesn't know where the fire is going to be. That is almost the only variable which they don't know about. We don't know where our next job is going to be, but we have to be ready.

This man had ten carts and horses and naturally he had ten drivers. There are many savings that could have been made, but were not for reasons which I shall not go into. We could easily have had a string of carts go along with one driver, but that wasn't done in this case. The first thing we did was to analyze that situation, exactly as Mr. Taylor has suggested, as it would be analyzed in a machine-shop. The laws underlying all similar situations we have found by practical experience are identical, and the only place where we fall down on those laws is where we haven't had sufficient experience or sufficient intelligence to make a success of it. There is not one exception to the rule; the application may be different, but the law holds good. Every one of those laws that you find in "Shop Management" we have found absolutely ridiculous at first, and absolutely perfect before we have done with them.

We analyzed this proposition and took time-studies. We

made out a time-table by which those men should go to work, and at the end of one day decided that five horses and five drivers should unload a good deal more than the men on the barge could give them. We found that the limiting feature was the number of carts that could back up to that barge and be loaded. To make a long story short, we found that a man ought to take twenty-three loads per day; he had been taking six. After giving this one day's study, we said, "Here, the price in this vicinity is $1.50 per day for a man, another dollar for the horse. The horse doesn't get the dollar, the man gets the dollar; therefore we can't put a bonus on the horse; and, incidentally, we must see that that man doesn't make the horse overwork and the man get the bonus, because that would not be in accordance with the square deal." We said, "According to the laws of averages derived from other experiences of Mr. Taylor, that man ought to have $1.50 a day if he does it his way, and he ought to have eighty cents more if he does it our way, and that makes $2.30."

Just imagine, gentlemen, what all of you would do to have a corresponding increase in pay for your daily work, a 60 per cent increase in your income. However, in this case that eighty cents is the difference between being rich and barely getting across. The first man made his bonus the first day and resigned. We picked out another man and he got his bonus and he resigned. In the meantime these young college men, wanting to be more efficient, disregarded some of the rules; they went to work a little too fast and had a whole lot of tasks set everywhere. They worked days, nights and evenings for the promotion that would come to them, and they finally had so many tasks demanding their attention that when man after man fell down, — I mean by that, each got his bonus and resigned — they could not take time to investigate. They were busy somewhere else. And so we went back to the old way — ten men — and we got eight loads a day. As soon as the reports came in to the New York office, the "flying squadron" came out to the job to see what

was the matter, and the leader said, "You must not let the first task that you set get away with you; you must stay with it until it is right." That is a very important thing.

So we did, and the first man again resigned. "Well," then they said, "we will knock off all business everywhere else and we will have one man walk along with each driver all day and every man will then earn his bonus and it will be all right." But we found that there was a little something more to do than that. We found, — and Dr. Taylor expressed that in his talk the first evening here — that we should have to teach the workman that creating a big output is not a crime against his fellow-man. Recognizing that point, we took off five carts to begin with and put them on some other job. That left only five carts. It would require five carts then to take care of the material that the extra number of men unloaded from the barge, and it was a case of taking that material or else preventing the men from having the job on the barge. That reversed the condition temporarily. We said to the men on the barge, "For every man that gets a bonus you get a bonus; if they all get a bonus you get a double bonus." And then we went to the foreman who was rather sore about this time, and we said, "Now for every man that gets a bonus you get ten cents a day. There are five of them; if all five get their bonus you get $1. And mind you, if all five don't get their bonus, you get the 'sack.'" And since that time every man on the job has earned $2.30 a day instead of $1.50, and worked nine hours and thirty-five minutes instead of ten hours, and the whips have been taken away, that being the only reward we could think of to give the horses.

I will describe one more case; one concerning the application of the instruction card. We had a job to make twelve benches, and we had our lumber come in endways so the conditions would be the same in each case. We had an athletic contest, starting all the men at the same time, but these men could not speak English and they could not read French, so we had difficulty in making out an instruction card, that being one of the first things that I fought Mr. Taylor about.

"There is no use," I said, "in making out instruction cards for these men, because they cannot read anyway." But if you read "Scientific Management" carefully, you will find that Mr. Taylor says an instruction card may be anything that will give the man the information. So we had a working exhibit made, and stereoscopic photographs of each step taken. Then we gave each of the men stereoscopic photographs, so that he could visualize the processes to be done. And we increased the output of every man an average of from two units to eight units per hour.

Mr. Robinson: Mrs. Gilbreth has brought up this matter of academic efficiency, and it seems to me that in the discussion yesterday we did not really get at it. I believe there is as much gain to be made in academic work as there has been in this other work, and that is about fifteen to one, as Mr. Barth says.

Can we apply the principles of Scientific Management to academic work? First, we must get a standard that the man can reach, then determine how near he comes to doing it and finally devise some way of getting him to do it. It has not been done yet, so far as I know, but it seems to me that principles of Scientific Management can be applied.

Now I want to read this which illustrates the present state of academic efficiency, not in all cases, mind you, but in a goodly number. In the students' room I have occupied in this college I read this, — and I mention it not as a reflection on this college, because it represents the college where I am teaching, and I think it represents generally the academic spirit. This is a motto on the wall in large letters: "There is just one good thing which may be said of studying; it lends by contrast a greater zest to those activities for which one really comes to college."

I asked my class in descriptive geometry the other day, when they came in with their lessons half prepared: "If you took this attitude on the football team and could not do anything, what would happen?" They laughed and said, "They would fire us out."

Now what are we going to do about it? In the first place we must do what Scientific Management does.

First, we must select our material a little more carefully, and then when we have got it we must keep our eye on it. And it seems to me the thing to go by is this one thing, the attitude of the student; has he the enthusiasm for his study that the ordinary man has for football? If he has not that enthusiasm he has got to get it, and if he cannot get it he had better go into some business in which he can get it.

I have one illustration. I was teaching in a technical school which had started anew. In the second year that school had one boy who seemed almost a hopeless case. He was likable, he had a good physique, he was a first-class young animal. But he had no moral nature to speak of. It seemed impossible to do anything with him. He would cheat in his examinations before your eyes and not know that he was doing anything out of the way. That school had had no athletics. They began football and baseball that year. This boy took a great interest in both. During his first year his studies were a failing business. By working on that boy, — it was a small school and we could get very close to the students — by working on that boy we got him tremendously enthusiastic over his football and his baseball. Since he was a simple-minded youth and did not have the traditions of older classes to form his mind, we were able to work that enthusiasm into his studies.

Now where is that poor kind of a boy. He graduated with A's in his studies, captain of the football team, captain of the baseball team, and we could leave him in an examination and let him have access to anything and he would not use it. He was a sport. He put the sporting instinct into his work. When he came out did he have to take two or three years to get adjusted to his work? No. He went right into his work with the same enthusiasm he had gone into his baseball and football, and simply went right up the ladder. The other day he was elected to a public position of honor and of responsibility.

That is what we want to get. How are we going to get it? I don't know. I have not solved the problem. I am merely stating it to you, and I want somebody to help me and help the rest of the college family to work it out.

MR. WEBSTER: There is one point that I am very glad has been brought out, because it is a point I should like to make myself. It is this: one of the speakers yesterday said, if I am not mistaken — I was very much astonished — that it turned out that the management as a rule has under Scientific Management about one man to every three workmen,— am I right? That is a capital thing to find out, and when you introduce that in colleges you will get similar results. At present we have one man handling an enormous number of men. So many that he does not look upon them as men; he looks upon them as people who trouble him.

Now, gentlemen, I should like to tell you one thing that I know something about. It is not in my institution, but it is in Princeton. Scientific Management has been applied at Princeton. If there are any Princeton graduates here I apologize for what I am going to say; it is complimentary to Princeton. But in the last fifteen years Princeton University has been made over. It has been made into a place where it is fashionable to study, where learning has become respectable. It was recognized by Woodrow Wilson and other people in authority there that men spent their time on something else. Why under the sun it is not recognized by everybody I don't see. And what did they do? They hired a lot of young men whom they called preceptors, paid them good salaries, and these young men were to sit by these students, three or four at a time, about the same ratio that you gentlemen of Scientific Management have discovered. And the same effort spent, ladies and gentlemen, in various ways will produce the same result. Only you must have feeling, you must have sympathy, you must have human nature. These addresses have interested me in proportion as they have brought out the human element.

Now, if the universities in this country cannot so lead

public opinion as to see that everybody who comes from a university shall be using himself at the very best efficiency there is in him, for the good of the whole people, these universities have no right whatever to exist or to spend any money.

THE CHAIRMAN: We have about half an hour. We have three speakers whom I should like to hear from, and I am going to ask them to confine themselves each to ten minutes. I am sorry to do it, but I must. Mr. Hollis Godfrey will now tell us something about the use of a planning board. I want to say that, if I am right, he knew absolutely nothing about molding machines six months ago. I do not believe he had ever seen one, and what he is going to tell us today is interesting to me because it shows how a man, who knew absolutely nothing about the business into which he went, was able to control some of the details which we have come to feel can be mastered by a man only after he has been on the job fifteen or twenty years.

MR. GODFREY: To begin, we must make a few definitions. All work in a scientifically managed factory is handled from the central Planning Department. The instrument by which the Planning Department or "Planning Room" controls the shop is the "Planning Board" or Bulletin Board, as it is sometimes called. The man who controls the board is the Order-of-work Clerk who is sometimes called the Bulletin Board Clerk. Briefly speaking, all knowledge of the progress of the work in the factory is shown on this planning board and all movement of raw and finished material from point to point. All beginning and ending of operations is controlled by the movement of the operation orders on the planning board. One may almost say that the planning board is a great bulletin board made up of group after group of small bulletin boards, each of which small boards represents a single machine or work place and each of which small boards has three sets of hooks, one over the other. When a job goes into the shop, that is, when the drawings, instruction cards etc. are ready, when the materials are all found to be on hand and

everything is ready to actually perform the work, the operation order which concerns a given operation goes on to hook No. 3, "Jobs ahead in shop," of the machine on which that operation is to be done. When the materials have been moved to the machine, the operation order goes to hook No. 2, "Jobs ahead at machine." When the job actually gets on the machine the order is moved to hook No. 1, "Job on machine." So that the man at the planning board knows at any time where a given job is by the movement of the operation orders on those three hooks. That is, the movement of all things in the shop is represented by the movement of the operation orders on the planning board.

The movement of the operation orders at the shop board, moreover, controls that most important of questions—"Which job shall we do first?"—for it is the order or sequence in which the orders are placed on hook No. 2 of the planning board that determines the order or sequence of the jobs that are done in the shop. One point more and the preliminary discussion of the planning board will be done. We can hardly pass on to the next problem without a word concerning the way the work goes from the board inside the planning room to the shop outside. When the order goes to hook No. 2, "Jobs ahead at machine," a duplicate order goes out into the shop on to a corresponding shop board, so that the order of work for the machine, as we call it, or the sequence of the jobs to be done, is the same on hook No. 2 of the machine bulletin board in the planning room as it is on the machine bulletin board out in the shop.

There are a whole series of questions which we can answer immediately by means of this planning board, besides that important question "Which job shall we do first?" and the subject immediately before us concerns some questions which we recently formulated at the Tabor Manufacturing Company. The order-of-work clerk at the Tabor is an able man with a very unusual memory. He could give out on call in a really amazing fashion all sorts of necessary shop information, but

that information depended on the memory of a single man. It had never been recorded or coördinated. It could not readily be passed on to another man. So we formulated the following questions for each machine in order to record and coördinate that necessary shop knowledge which the order-of-work clerk possessed. The first of these questions is: "If a machine breaks down what other machine can do the work?" (a question which comes without any warning in any plant). Second, "If a man is out what other man can do the job?" Third, "What is the cost of any operation on any machine for any hour, or what is the total cost of all operations going on on all machines in any hour?" To answer these questions we collected and coördinated all the material we could get and finally constructed a planning board chart, a copy of a small portion of which is shown here.

*PLANNING BOARD CHART*

| 1<br>*Machine No.* | 2<br>*Shop Board* | 3<br>MAN RUNNING<br>*Name* | 4<br>*No.* | 5<br>*Wage* | 6<br>*Capacity* | 7<br>*Machine Cost* | 8<br>*Machine Man from* | 9<br>*Machine Work can go to* |
|---|---|---|---|---|---|---|---|---|
| Grinders | | | | | | | | |
| G. 17 | B – 3 | Smith | 26 | 30 | S. – D. 11 | 28 | S.L. 14 | G. 26 |
| G. 26 | A – 4 | Church | 31 | 25 | G. 17 – G. 12 | 22 | S.D. 14 | G. 17 |
| Lathes | | | | | | | | |
| L. 14 | C – 3 | Manning | 47 | 28 | G. 17 | 26 | X | L. 22 |
| L. 22 | C – 6 | Hayes | 83 | 34 | A.A.M. | 29 | X | L. 14 |

In column No. 1 is the machine number. There are represented here two grinders, grinder 17 and grinder 26, and two lathes, lathe 14 and lathe 22.

There are nine things that we wanted to show on this chart. There is the machine number in column 1, and the shop board on which operation orders for that machine are posted in column 2. There is also the "Man Running," his name, number, wage and capacity. (Columns 3, 4, 5 and 6.) "Capacity" is the only one of those headings that needs explanation. Take G. 17, for example. Smith's capacity means the machines that he can run besides G. 17. He can run not only G. 17 and "S." (which means that he can run any of the grinders) but also "D. 11," which means that he can run

one of the drills — drill No. 11. Next comes the cost number column which means the average cost of running G. 17 one hour in the preceding year. Next is the column showing the machines from which a man could come to run G. 17. In the last column are entered the numbers of machines which can do the work of G. 17.

To get these data we had to go around and find out all the men who could run different machines. Suppose G. 17 breaks down. We look over in column 9 and we find instantly that the work can be transferred to G. 26, and, if G. 26 is free, the work is transferred immediately to that machine. If Smith, who is regularly on G. 17, does not come in, we can look down the planning board chart and determine which man can go on G. 17. We know from the "S." that any one who can run a grinder can run G. 17, and the man who has the least important work can be swung over to that; or we can take the man on L.14, because he is also trained to run G. 17. We have answered two of our questions. We have answered the question, "What machine can we put work on at any moment?" and we have answered the question, "What man can be put on a given machine in case the regular man is out?"

The third question, the question of cost per hour, is answered by simply adding together the cost of running the machine and the cost of workman's wages (columns 5 and 7) and the sum of the two gives the cost per operation hour.

On the next line we have: "G. 26," shop board A — 4; man running, Church, No. 31, wages 25 cents per hour; capacity, "G. 17, G. 12." Suppose we consider this case for a moment: Church could be swung to G. 17 or G. 12. He cannot run the other grinders. The cost number of his machine is 22. A man can come to this grinder from one of the same grinders or from D. 14, while the work can be transferred to G. 17, which does the same class of work.

Against L. 14 we have an "X," which indicates that no man excepting the L. 14 man can run that machine, while L. 22

can be run by Hayes only, who is an "A.A.M." — an all-around man.

If any plan is to be a success there has to be some inspection for it. So we worked out an inspection form which has in the first column the machine numbers, G. 12, G. 13, G. 14, etc., and then has in the following columns the headings, "Hours," "Preparation," "Sequence" and "Remarks."

Planning Board Inspection Form

| *Machine Number* | *Hours* | *Preparation* | *Sequence* | *Remarks* |
|---|---|---|---|---|
| G. 12 | | | | |
| G. 13 | | | | |
| G. 14 | | | | |
| G. 15 | | | | |
| G. 16 | | | | |
| G. 17 | | | | |

"Hours" means that on the planning board we have to see that there is ten hours' work planned ahead for every workman. "Preparation" means that work shall have been prepared or planned for ten hours' work ahead. If the jobs take up less than ten hours, we make preparation for three jobs ahead. Either three jobs, or ten hours' work ahead is the rule.

The third column is "Sequence" and that indicates whether or not the order of work is being followed. The fourth is for "Remarks."

Suppose we illustrate an inspection by the aid of this chart, and suppose we say that the order-of-work clerk is inspecting the planning board on the grinder division. First, he looks at G. 12 and sees if there are ten hours work ahead for the workman. Second, we have a red tag which indicates how much preparation is out. He looks at the position of this red tag to see if the tool lists, inspection cards, drawings, etc. are ready for the workman to do three jobs ahead; that is, to see if he has all the tools and instructions he needs. Third, he looks to see if the proper order of work is being followed, — that is, if the sequence is being followed, if the jobs on the hooks represent the way in which the workman is to do his work. Fourth, he glances to see if there is

anything beside these matters which is out of the way. Now as to the order-of-work clerk's action on the basis of this inspection. If he sees in G. 14 that the man has not ten hours work ahead he simply draws a line opposite G. 14. He comes to G. 15 and sees that preparation is only made for two jobs instead of three. He draws a line there. He looks at G. 16 and sees that the sequence is not right; he had a stock order ahead of a shipping order on those books and he draws a line there. He finds that the time-study man has made an error in figuring the time-units necessary for the job on G. 15, and he enters "T.S." in the remarks column. By that series of checks, therefore, all the order-of-work clerk has to do beyond his inspection is to hand the inspection sheet over to the recording clerk and the other clerks responsible and say, "Why is not that right?" The order-of-work clerk should use such an inspection on himself and find his own errors by such inspection.

Such a scheme as this one illustrates the principle laid down by Mr. Taylor of collecting the knowledge of the shop which exists only in men's minds, recording it, coördinating it and putting it in a form easily available for use. It has already shown its use and has made possible a notable increase in the speed and accuracy of running the board.

The Chairman: There is one more speaker. I do not often give Mr. Taylor instructions, but last night I told him I wanted him to take one problem out of his experience and tell us how he solved it; but I have changed my mind about it now and I am going to ask him to simply close this conference. I am sure that some of the things he has heard and seen have made an impression on him, and I should like him to use his time as he sees fit. Mr. Taylor.

Mr. Taylor: The first piece of time-study that I ever saw was made by a professor who was making a time-study of the students under him. Any of you may have had the good fortune to go to school at Phillips Exeter Academy, and many of you who have not had that good fortune, have heard of Professor George W. Wentworth, never known as

Wentworth at Exeter, but known as "Old Bull." With all of us at Exeter it was a matter of very great surprise that Bull Wentworth was able throughout the whole year, from the beginning to the end, in whatever branch of mathematics he was teaching, to assign us a lesson for the next day which would always take us just so long to get. It was astonishing, perfectly surprising. He became known as the most severe master at Exeter; he drove the boys harder than anybody else. We thought that by some intuition he found out the fellows who were not working. It would sometimes be a stupid boy and sometimes it would be the brightest boy in the class who was not working. It did not make a bit of difference to "Old Bull" who it was; it did not matter whether the bright boy was reciting fairly well or not. That was not what he was bothered about. He found out somehow or other that that fellow was not working as much as he ought, and he expected about three or four times as much of the smart fellows as he did of the stupid ones. That is rather unusual. The moment he found that such and such men were not working he made a list of them, and at least half of two days out of every week at the recitation was given to roughing those boys in the presence of the class. He would call them up, stand them up in front and ask them all kinds of questions in his tremendously sarcastic manner. The whole class was familiar with this roughing operation, and it was sport for all the rest of us. Whenever "Old Bull" would ask a fellow a sarcastic question, the whole class would get up and howl. The fellow would answer to the best of his ability, but after three or four days of this he would get sick of it and go to work. The moment he went to work "Old Bull" had some way of finding it out, and he would stop roughing him and take another man.

I don't know whether Bull applied time-study to that, but he did apply time-study to another thing. It was a long time before we found it out. He had a watch in the front of his desk and we all knew that the watch was there, but we could not find out what it was for. After a while we found out

what he was doing with it. He spent at least half of one recitation every week in making a time-study of the boys. We did not know what it was for. He would give a certain series of problems, probably selected by him with the greatest care as test problems, and he insisted that on those days as soon as a boy had solved a problem he should raise his hand instantly, and he would call his name. That made quite a little emulation among the boys; all of them wanted to be the first to be called. And they could not fake it. Lots of us would have been entirely ready to fake it so as to be first to be called, but we never knew when "Old Bull" was going to ask us to get up and shout, so we could not fake. That kept the matter straight. Whenever a fellow held up his hand it was the genuine thing. When he reached the middle of the class this calling of names was stopped, and he would go on and do something else, start another problem.

Now what was happening was this: "Bull" was getting the ratio of his own mind in solving each of these problems as they came along to the mind of the man in the middle of the class. He was making a time-study on mental ability. And by means of that knowledge he found the progress which his class was making, and month by month the men grew much more rapid and more efficient. He kept up a continuous knowledge of the ratio of his mind to the mind of the rest of the class, and by that means he was able, in assigning a task for the next day, to give exactly the right amount for the men to do. He would simply make a time-study for himself of the various problems he was going to give out and multiply that by the ratio, and then he had just two hours or two hours and a half of work that he made us do, and he kept the average of the class doing that right straight along. That is the first case of scientific time-study that I ever saw and it was mightily effective.

I am speaking merely from analogy, but I am absolutely certain that there are thousands of similar cases in which accurate knowledge ought now to be applied to academic work in place of some one's "think so," some one's guess about

it, some one's general experience, some one's rule-of-thumb. Most of your college work is now run by rule-of-thumb just as the workman's is run by rule-of-thumb. That is the point that I want to bring out; what these things are I don't know, no one knows, but that they exist in academic work just as they exist in all the rest of the work in this world, I am absolutely certain.

MR. CARDULLO: Just one question. Can you run it in any other way than by rule-of-thumb when you have a ratio of one instructor to twenty students?

MR. TAYLOR: Well, now, "Old Bull" had fifty in his class and he was doing something all right. In many cases I quite agree with you, the point is well taken; that is, that the ratio of instructors to students is so small that you don't find time to do anything but the rough part of the work. I agree entirely that you will have to have more men, more time-study men. In that matter you are entirely right, but something can be done. I think a change in the viewpoint is something; a belief in the possibilities is something.

MR. CARDULLO: I find I can prepare instruction cards but I cannot see that those instructions are carried out.

MR. TAYLOR: That is right; that is entirely right. You must have more men to do it. That is entirely true, but I think the more men will be forthcoming.

There ought to be a vast amount of that work done, and in the bulletin Mr. Cooke wrote that is just what he tried to point out to you, gentlemen.

Now I want to say another word, a word that I did not have an opportunity to take into the conference on academic efficiency, and something which I am quite sure that you gentlemen do not realize; namely, that Mr. Cooke was well qualified to speak on the subject on which he did speak. You think that he was "butting in" on academic matters. Now I want to tell you, gentlemen, that Mr. Cooke was perhaps as well qualified as any man in this country, or better qualified, to speak on the subject, to write on the subject that he wrote upon. He was qualified from experience, —

not experience in that direct line, but experience in a line which is so analogous that there is comparatively little difference. Mr. Cooke was chosen by Dr. Pritchett of the Carnegie Foundation as the man to investigate academic efficiency because of his special qualifications to do it. Mr. Cooke was the man who was chosen, — when nineteen out of twenty of the Council of the American Society of Mechanical Engineers believed, firmly believed, just as the nineteen out of twenty professors in the average university firmly believe, that no man inside or outside of the university can do very much towards increasing the efficiency of the management of that university — Mr. Cooke was chosen, an outsider, a junior member of the society, not being at all familiar with the affairs of the society or with the management of the society, to reorganize the management of the American Society of Mechanical Engineers. For a year and a half Mr. Cooke did for the American Society of Mechanical Engineers just what some day some man is going to do for your universities, and the sooner the better. Mr. Cooke investigated every activity of the American Society of Mechanical Engineers, made a scientific investigation of it; and by that I do not mean that he himself made this investigation, but in every case he consulted one or more experts, the best that could be had in the country, and asked their advice and called them in in consultation as to every trifling element affecting the management of the society. Nothing was too small, nothing was too great to investigate. Let me say what the principal object of this investigation was, and I think it will appeal to you gentlemen. It ought to appeal to every professor in every university. The principal object of Mr. Cooke's investigation of the American Society of Mechanical Engineers was to free the head men in that society, the men who were busy men, men whom you may call relatively to other working people, the high-priced men, from all routine work, from all drudgery, from all trivial decisions; so as to leave them absolutely free from harassing details, so as to put them in the position in which they could devote their

energies to the vital interests of the society. That was the first and great object which Mr. Cooke had in view. So he studied the activities of all of the head men of the society and found out that a large part of their time was taken up in doing trivial matters that a cheaper man could do. He then proceeded to eliminate all of those trivial activities from these men and hand them over to cheaper men. In order not to interfere with the success of these men, it became necessary to be sure that these cheaper men would do these various trifling things, or less important things, if you choose to call them so, just as well as the high-priced man had done them before. Therefore, every one of these activities small and large, had to be standardized, had to be studied in the most minute way; the best thing had to be found and then a standard established with a system of daily and weekly inspection from the outside. Some man comes in to inspect this clerk's duties, that clerk's duties, so that the standards that have been set up for the American Society of Mechanical Engineers are never allowed to fall down. Then the secretary and the auditors, all of the important men of the society, are informed by summarized reports at frequent intervals concerning the way in which all of these details are being carried out. Those are the checks, so that the affairs of the society are carried out far better than they ever were in the past; are carried out by cheaper men; and the final result is that the men who are managing the society are at least, man for man, four to six times as efficient towards making progress as they ever were in the past. Mr. Cooke had the help of a committee who were very much in earnest. All that the committee did was advisory work. No committee ought to do anything but advisory work. Executive work on the part of a committee is an anachronism and ought to be stopped. You people in the colleges are doing much of it. Executive work should be done not by a committee but by a man. No such thing in the world now as executive work in a well-regulated institution is done by committees. The committees of the American Society of Mechanical Engineers,

and there are many of them, are run now on exactly that principle. All that they have to do is to exercise their judgment. The society supplies, — not always cheaper men, sometimes very high-priced men — but always some one else, to do the executive work of a committee.

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| Smith, Robert E. | Smith & Son | White River Junc., Vt. |
| Smith, Stanton E. | General Manager, Tilton Optical Co. | Tilton, N. H. |
| Smith, Walter C. | Sec'y and Ass't Treasurer, Vermont Farm Machine Co. | Bellows Falls, Vt. |
| Sprague, H. W. | Nesmith Shoe Co. | Brockton, Mass. |
| Stevens, Albert E. | Supervisor of Expenses, Wm. Filene's Sons Co. | Boston, Mass. |
| Stevens, Roland E. | Vice-President, L. E. Knott Apparatus Co.; Attorney at Law at White River Junction, Vt. | Boston, Mass. |
| Stillman, A. R. | Office Manager, C. B. Cottrell & Sons Co. | Westerly, R. I. |
| Sullivan, J. M. | Weekly Bulletin Publishing Co. | Boston, Mass. |
| Sweet, Homer W. | Public Accountant, Harvey S. Chase & Co. | Boston, Mass. |
| Szepesi, Eugene | Textile Engineer, Szepesi & Farr | Boston Mass. |

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| Taber, C. H. | President, American Pad and Paper Co. | Holyoke, Mass. |
| Talcott, George S. | Secretary and Treasurer, American Hosiery Co. | New Britain, Conn. |
| Tarbell, John A. | D. Whiting & Sons | Charlestown, Mass. |
| Tarr, Forrest E. | Div. Const. Engineer, New England Tel. & Tel. Co. | Boston, Mass. |
| Taylor, Frederick W. | Consulting Engineer | Philadelphia, Penn. |
| Temple, Edw. H., Jr. | Superintendent, Aberthaw Construction Co. | Boston, Mass. |
| Thompson, F. W. | Accountant, Berlin Mills Co. | Berlin, N. H. |
| Thompson, Sanford E. | Consulting Engineer | Newton Highlands, Mass. |
| Thompson, Mrs. S. E. | | Newton Highlands |
| Tobin, John F. | General President, Boot & Shoe Workers' Union | Boston, Mass. |
| Torrey, Harry K. | Secretary to Gov. Bass | Concord, N. H. |
| Tuttle, M. C. | Secretary, Aberthaw Construction Co. | Boston, Mass. |
| Tuxbury, Charles | Dwight Tuxbury & Sons | Windsor, Vt. |
| Tyler, Victor | President and Treasurer, The Acme Wire Co. | New Haven, Conn. |
| Upham, J. Duncan | Treasurer, Sullivan Machinery Co. | Claremont, N. H. |
| Vaitses, Paul S. | Factory Accountant, Regal Shoe Co. | Boston, Mass. |
| Vaitses, Mrs. P. S. | | Boston, Mass. |
| Varney, Manley H. | Overseer Finishing Department, Amoskeag Mfg. Co. | Manchester, N. H. |
| Vawter, F. M. | Vice-Pres., Baker-Vawter Co. | Holyoke, Mass. |
| Waite, C. H. | Treasurer, Taylor-Burt Co. | Holyoke, Mass. |
| Wakeman, Samuel W. | New York Shipbuilding Co. | Camden, N. J. |
| Walker, George | Superintendent, The Taylor-Burt Co. | Holyoke, Mass. |
| Warren, Edmund L. | W. H. McElwain Co. | Boston, Mass. |
| Warts, Sherman | | Windsor, Vt. |
| Webb, B. S. | President, New England Electric Works | Lisbon, N. H. |
| Webner, Frank E. | Vice-President, American Cost Accounting Co. | New York, N. Y. |
| Webster, Arthur J. | Professor of Physics, Clark University | Worcester, Mass. |
| Webster, Fred | Advertising Manager, American Writing Paper Co. | Holyoke, Mass. |
| Webster, Leon | Assistant Superintendent, Royal Worcester Corset Co. | Worcester, Mass. |
| Wellman, Harry R. | Asst. Sec'y, Boston Chamber of Commerce | Boston, Mass. |

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| Wells, A. E. | Superintendent of Shops, Sibley College, Cornell Univ. | Ithaca, N. Y. |
| Welton, Benjamin F. | Sec'y, Budget Exhibit Com., N. Y. City | New York, N. Y. |
| Wheeler, H. G. | Traffic Chief, New England Tel. & Tel. Co. | Manchester, N. H. |
| Wheeler, Leonard D. | Treasurer, Ottaquechee Woolen Co. | White River Junc., Vt. |
| White, L. C., Jr. | Treasurer, Amsden Lime Co. | Amsden, Vt. |
| Whitney, W. A. | President, Emerson Paper Co. | Wendell, N. H. |
| Willers, Diedrick K. | German-American Button Co. | Rochester, N. Y. |
| Winestock, O. I. | President, Winestock Mfg. Co. | Perkinsville, Vt. |
| Witherell, F. W. | Efficiency Engineer, Suffren & Son | New York, N. Y. |
| Wolf, Robert B. | Superintendent, Burgess Sulphite Fiber Co. | Berlin, N. H. |
| Worthen, H. W. | District Commercial Manager, New England Tel. & Tel. Co. | Manchester, N. H. |
| Worthen, James C. | American Glue Co. | Gloucester, Mass. |
| Worthen, Thomas W. D. | Member Public Service Commission | Concord, N. H. |